metal finishing

APPLICATION, ELECTRODEPOSITION, VITREOUS ENAMELLING,
ANIZING, METAL SPRAYING and all METAL FINISHING PROCESSES

Vol. 4 No 45. (New Series) SEPTEMBER, 1958

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metal finishing Journal

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THIS JOURNAL IS DEVOTED TO THE SCIENCE AND TECHNOLOGY OF PAINT APPLICATION, ELECTRODEPOSITION, VITREOUS ENAMELLING, GALVANIZING, ANODIZING, METAL SPRAYING & ALL METAL FINISHING PROCESSES. THE EDITOR IS PREPARED TO CONSIDER FOR PUBLICATION ANY ARTICLE COMING WITHIN THE PURVIEW OF "METAL FINISHING JOURNAL" AND ALL SUCH ARTICLES ACCEPTED WILL BE PAID FOR AT THE USUAL RATES.

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SUFFICIENT UNTO THE DAY

ELSEWHERE in this issue "Platelayer" draws attention to the findings of a survey recently carried out in the U.S.A. the results of which are a significant commentary on an important trend in present-day industry. The survey indicates that an important source of technical information for industrial concerns is the practice and experience of their competitors in the same field. That this should be the case represents a very considerable liberalization of thought among those responsible for the administration of industry.

With the passing years, it has come to be better appreciated that successful operation depends in very small measure on the maintenance of secrecy about some process than on efficiency of administration, organization, production and salesmanship, and with this growing awareness has grown an increasing readiness to discuss technical problems more freely.

One industry which has emerged very rapidly from sequestered isolation to broad and liberal discussion of its problems is the hot-dip galvanizing industry which in July of this year held the fifth in the series of biennial international conferences which was inaugurated in Copenhagen in 1950. *The records of these conferences, the latest of which is fully reported in this issue, show that the industry has become aware with remarkable rapidity of the value of open discussion of its problems.*

The fact that the whole of this issue is devoted to a preliminary report of the proceedings of the conference (the full official text of the papers and the authorized version of the discussion will be published by the Zinc Development Association later this year) is a measure of the significance which we attach to the activities of the hot-dip galvanizing industry. Zinc, by virtue the very special protection which it can afford to steel and the efficiency and variety of ways in which it can be applied, has gained for itself a special position in the hierarchy of protective coatings.

As is the case with many other materials applied as a coating to steel to protect it from the corrosive influences of its environment, the durability of the protection afforded depends in great measure on the thickness of coating applied, a point which was brought out very effectively in a contribution by Dr. H. Bablik to last month's issue of this journal. The factors which control the thickness of zinc coatings which can be applied by hot dipping are varied but in the main they all result in the formation of a layer of iron/zinc alloy which constitutes a relatively significant proportion of the total coating. In the case of ware galvanized after manufacture, a practice still in very wide use, the presence of this alloy layer contributes to the adhesion of the coating, detracts nothing from its corrosion resistance, but is in itself brittle and therefore extremely liable to crack and exfoliate if the metal to which it is applied is subjected to deformation. The formation of this alloy layer can be inhibited by the addition of aluminium to the molten zinc, but this addition automatically sets a top limit on the thickness of coating that can be applied. It does therefore emerge that in many cases the user is faced with a choice between a galvanized sheet which can be fabricated without damage to the coating, but which bears a thinner coating and therefore less long-lived protection than does an article galvanized after manufacture.

In seeking the undoubtedly desirable characteristic of formability, sight must not be lost of the primary reason for the application of zinc which is to provide adequate protection against corrosion.

Talking Points

by "PLATELAYER"

TOPICAL COMMENT FROM THE MAIN LINES AND SIDE LINES OF METAL FINISHING

CANNED WATER

THERE is a considerable revival of interest in the possibilities of aluminium in canning, and we may well see considerable progress in this field, despite the abortive results of previous attempts by the industry to oust tin-plate from its great stronghold. One pointer is the fact that the well known Evian mineral water is being marketed in anodized aluminium cans in place of bottles, in increasing quantity. One 2.7 litre can contains as much as three glass bottles, and the container is a fraction of the weight of the bottle ; this is one of the few cases where aluminium offers a real advantage over tin plate, which would probably impart a tainted flavour to the water, even if it were successful in other respects.

The manufacture of this kind of container involves large-scale anodizing plant for the treatment of the cans at high speed, as it is only by such methods that the process can be made into a practicable proposition. An ingenious method of feeding the current to the cans is used. Electrodes enter the anodizing solution inside the can, which is immersed in an outer tank of electrolyte containing further electrodes. There is no electrode contact with the can itself, which eliminates one of the major difficulties in anodizing.

ASK YOUR COMPETITORS!

ONCE one begins to delve into simple matters there is no knowing what surprising facts may emerge. The U.S. Office of Technical Services is carrying out a survey of the nature and methods of solution of technical problems by manufacturing companies.

Of the 500 firms questioned in America, no less than 155 had received technical information or assistance in these matters from competitors, of all people. This assistance was, for the most part, of a general nature, far fewer firms having been assisted in the solution of specific problems by competitors. The tendency for firms to exchange general technical information is obviously very widespread across the Atlantic and is becoming increasingly so in this country.

Less surprising, but interesting to have confirmed, is the fact that about half of the firms gave trade and technical periodicals as their principal source of information on new developments and an equal number named their suppliers in this connection. Much lower on the list came exhibitions, meetings, customers and so on. But the big blow to the self-esteem of the technical expert is that only 17 per cent of the firms questioned mentioned their own technical employees as their main source of information on developments in their industry.

Truly, the boffin also, like the prophet of old, is not without honour except in his own country!

MORE AUTOMATION

IT looks as though one source of light relief at dull papers is going to be lost to us lecture-goers. The misplaced slide, or the occasional one which is inserted upside-down, may soon become a rarity. Magnetic tape recordings of commentaries can be coupled with film-strip projectors by a newly-developed system, so that an illustrated lecture can be given from tape automatically, each slide appearing at the appropriate time in the discourse.

The point of the scheme is that an illustrated technical story can be put across to an audience at a fraction of the cost of a sound film. The inaudible or inarticulate lecturer is also done away with at the same time.

A special projector is required, but the advantages of the idea are obvious, as an extension of the use of the technical film, the cost of the projector being small in relation to the savings that can be effected.

DOTTY PAINTS

A CLASSIC joke that used to be played on apprentices was to send them out to buy striped paint — a product which appears to reach the epitome of impossibility.

In the U.S.A. however, polka dot or "spatter" paints are now becoming highly popular for domestic use, although they have not yet entered the industrial field to any large extent.

These paints can be applied by roller or even by brush without breaking up the dot formation. Upwards of fifty different colour combinations are available.

It is however, still not possible to buy striped paint, to the best of my knowledge. No doubt it will come — and then it will be some poor salesman's job to make people want it.

FROM THE CRADLE . . . .

THE names of three companies in a group which advises on personnel matters are Management Selection Ltd., Management Remuneration Ltd., and Management Succession Ltd. Hatches, matches and dispatches ?

5TH INTERNATIONAL CONFERENCE ON HOT-DIP GALVANIZING

SCHEVENINGEN and KNOKKE, JUNE 22-27, 1958

THE fifth International Conference on Hot-Dip Galvanizing was held this year in Holland and Belgium from June 22 to 27 under the patronage of the Brussels World Fair. The Conference was the first to be held under the aegis of the European General Galvanizers Association. Under the auspices of the European Association all arrangements were made by the two National Associations of the Netherlands and Belgium — Vereniging van Nederslande Verzinkerijen and Belgogalva. The Zinc Development Association, U.K., which acts as the Secretariat of the European Association had overall responsibility in respect of preprinting and circulation of papers.

The Conference opened at the Kurhaus Hotel at Scheveningen on Sunday, June 22, where delegates were welcomed at a reception by Mr. Ch. van Kempen, president of the Netherlands Galvanizing Association. The whole of the following day was devoted to visits to a number of galvanizing works and in the evening delegates were conveyed by special train to the Belgian resort of Knokke-le-Zoute.

It was in the Casino at Knokke that all the technical sessions were held, and on the first morning there the delegates were welcomed to Belgium on behalf of the Belgian Galvanizing Association by Mr. R. Palmers. In expressing a welcome to the Conference on coming to Belgium during the period of the Brussels Exhibition, Mr. Palmers said that it gave him very great pleasure to note that the regular increase in the numbers attending the International Conferences since their initiation in 1950 had continued and at the present Conference there was a larger attendance representative of a greater number of countries than ever before. He thanked all those who had played any part in organizing the Conference and he was particularly happy to express a greeting to Dr. H. Bablik, president of the European General Galvanizers Association.

Thanks were expressed to Mr. Palmers for his welcome by Mr. E. M. Wilson, chairman of the U.K. Hot-Dip Galvanizers Association. The delegates greatly appreciated the warm welcome which had been extended to them in both countries and he had no doubt that they would all look back on the present Conference as having been one of the most successful ever held. Mr. Wilson laid stress on the great benefits which had resulted from

Top Table Personalities at the opening of the Conference Technical Session at Knokke. Left to right : Dr. R. Haarmann, Mr. Ch. van Kempen, Dr. H. Bablik, Mr. R. Palmers, Mr. E. M. Wilson, Mr. R. L. Stubbs, Mr. A. Ollivet.

An address of welcome is delivered to the delegates by Mr. R. Palmers.

the formation of the European General Galvanizing Association which had done much to maintain effective contact between galvanizers in many countries during the two years which intervened between the holding of the Conferences. Furthermore, the increasing interest in, and popularity of, the Conferences had brought about a change of character in that much of the earlier intimate atmosphere of the discussions had necessarily disappeared, and proceedings tended to be more formal. However, the informal exchange of ideas on technical and administrative aspects of galvanizing had continued through the medium of the European Association.

Mr. Wilson then introduced Dr. H. Bablik, president of the European General Galvanizers Association, who said that the Conference was attended by more than 350 delegates coming from twenty-two countries, and he extended a special welcome to those who had made the long journey from North and South America, Australia, Africa and Russia.

Dr. Bablik said that it was most rewarding that so many people who were competitive in industry and representing many divergent political views should meet together on the common ground of technical discussion. He would however, urge upon them that technology should be no more than a tool for living, an accepted condition of life but not life itself. It was for technical progress to make life easier, but not so easy that man was deprived of the need for effort and the making of decisions. It was with the hope that the deliberations of the Conference would bring increased understanding and friendliness to all that he declared the Fifth International Galvanizing Conference open.

During the ensuing technical sessions over 30 papers were presented and discussed. These were presented in the form of a principal paper on the theme of the session, accompanied by one or more subsidiary papers, either amplifying the theme or commenting on some of the points raised in the main paper. Abstracts of these papers are published below, together with a *Metal Finishing Journal* report of the discussion following their presentation. The full text of the papers, together with the officially edited version of the discussion will be published later this year by the Zinc Development Association to whom thanks are due for assistance and the provision of facilities in the preparation of this report.

On the afternoon of June 24 delegates were conveyed to the Brussels World Fair where, following a reception at the Palais de l'Elegance they had the opportunity to inspect a number of the pavilions and exhibits.

The formal proceedings of the Conference concluded with a Banquet in the Casino at Knokke, and on June 27 the opportunity was provided for delegates to visit a number of works of galvanizing interest in Belgium. Brief descriptions of the galvanizing installations in some of the works visited in Belgium and the Netherlands are included in this report.

* * *

Session I

HUMAN PROGRESS THROUGH TECHNICAL PROGRESS

Chairman : MR. S. K. BERNT
(N.V. Plaatwerkerij en Verzinkerij)

Human Progress through Technical Progress—1

R. PALMERS
(Phenix Works S.A.)

MODERN developments in the methods by which galvanizing baths are heated have brought improvements in working conditions; the use of gas and fuel oils has reduced handling, improved the atmospheric conditions in the shop and allowed baths to be more accurately controlled so that the danger of burst pots has been effectively eliminated.

The introduction of mechanized handling equipment in all departments has cut down the manual labour previously required, and made the job of the galvanizer less arduous.

Technical progress has led to increased production and more economical running of the plant. This has resulted in large sums of money being spent on improving working conditions in the shop, and on facilities such as showerbaths and canteens.

The workers now enjoy a much higher standard of living than in the past ; not only are wages higher but working hours are shorter, enabling the employees to develop interest of their own. Men and management are combining to extract from technological advances the maximum benefit in terms of efficient work performed in conditions both healthy and pleasant.

Human Progress through Technical Progress—2

E. M. WILSON
(Henry Hope and Sons, Ltd.)

HUMAN progress involves the problem of leading a full life with proper proportions of work and

leisure with an adequate contribution to the needs of others but with a reasonable share of the good things of life for oneself. How best this can be achieved and the extent to which technical progress has contributed towards its achievement is the subject of some divergence of view.

Technical progress has made possible a considerable increase in the amount of leisure time available and in some respects, *e.g.*, through television, contributed to the occupation of leisure time. Technical progress has also improved working conditions and reduced manual effort and the trend in this direction is likely to continue, particularly with the advent of electrical power at an economic price derived from atomic plants.

One aspect of technical progress is the holding of international conferences, and an ancillary effect of these is a great increase in communications between individuals with consequent advantages, not necessarily measurable in terms of galvanizing efficiency.

DISCUSSION

MR. F. C. BRABY (Fredk. Braby & Co. Ltd., U.K.) said that in this sphere of the improvement in human relations brought about through technical progress he would like to refer to the position of the supervisor. It was the supervisor who had the task of implementing improvements in technical knowledge in terms which could be understood and followed on the shop floor. In that respect his importance increased continually as technical progress improved, and for that reason the industry in the United Kingdom had organized a series of conferences especially for supervisors under the auspices of the Hot-Dip Galvanizers Association. There had been three such conferences up to now, and another was being arranged for next year. Not only had they provided the opportunity for technical instruction and the exchange of knowledge, but they had also enabled supervisors to pool their own experiences in dealing with personnel problems. The attendance at the conferences had been excellent, and they had been widely representative. The sessions always included a review of current galvanizing techniques and some kind of forum or brains trust on general problems, with emphasis, of course, on supervision, including the organization of production and the handling of the galvanizing team.

These conferences were open to managers and supervisors from other countries. They had had the pleasure of welcoming one or two, but they would like to see many more and would be happy to send particulars of the next conference to anyone interested. He had to add the caution, however, that as a rule accommodation was somewhat limited, and it would be appreciated that the courses were intended primarily for United Kingdom supervisors, so that it might be necessary to restrict the attendance to some extent. An exchange of ideas with supervisors from other countries, however, would always be helpful and would be welcomed.

President of the European General Galvanizers Association, Dr. H. Bablik, opens the Conference.

He wished also to mention the special conferences arranged by the Productivity Committee of the Hot-Dip Galvanizers Association on methods of improving production in galvanizing departments. These other conferences were mainly intended for a higher grade of management, and they also had been very well attended.

Before the formation of the Hot-Dip Galvanizers Association there had been very little contact between galvanizers in the United Kingdom except in the commercial field. The change which had occurred in the relations between galvanizing firms and at all levels in such firms within the past few years was encouraging and showed that very great human progress had occurred, entirely due to the desire to co-operate in obtaining and exchanging information on progress of a technical nature ; so that it could justly be said that by such means galvanizing had provided an outstanding example of the theme of the Conference.

MR. H. BUSCH-JENSEN (J. Chr. Jensens Galvaniserings Establissement, Denmark) said he believed that human progress might not necessarily follow from technical progress.

No one would want to discuss what was meant by technical progress, but when talking of human progress there would be great differences of

opinion about the meaning of those words. Western civilisation had been built up on technical progress, which in its turn was based on the comprehension of laws of cause and effect and the principles of analysis and deduction. They had been so obsessed with this technical progress that they had hardly had time to study this same law as it worked in the mind of man. It might be said as a paradox that through their technical knowledge they ran the risk of causing the same destruction in the mind of man that they were now able to bring about in the outer world through their knowledge of the laws of nature. That was, of course, an exaggeration, but he said it to emphasise the point which he desired to make.

It was true that technical progress had resulted in such human progress as Mr. Palmers had mentioned, but that had almost all been achieved in the material sphere — such things as easier working conditions, shorter working hours and so on. That stage of improvement or progress was probably almost over. There might be some works in which there was still something to be done in these respects, but such improvements had now had the character of being inevitable. It seemed true to say, however, that already technical improvements might have led to too many technical conveniences. People did not read any more ; they watched television. In short, through better techniques they were in danger of losing their capacity to do things themselves, and even, perhaps, of thinking their own throughts. What was worse, the ordinary worker might have too much leisure time, whilst the specialist — the man who must work hard to keep the complicated technical apparatus running — might have too little.

It would be a good thing if the human progress of the ordinary worker and the specialist could be co-ordinated. He did not share the belief that human progress was linked automatically with higher wages and greater leisure. Very few people had the mental energy needed to develop themselves mentally and spiritually.

* * *

Session II

PREPARATION OF MATERIALS

Chairman: MR. G. PIPER

(Nordic Circle of Hot-Dip Galvanizers)

Efficiency of Hydrochloric Acid Pickling

F. SJOUKES

(N. V. Plaatwakaig en Verzinkerij)

THIS paper deals with the efficiency of hydrocholoric acid as a pickle solution, and it is pointed out that it is possible to save up to 20 per cent. of the acid consumed without affecting the time of pickling.

A formula from which the acid losses can be calculated, but as the formula is rather complicated, three graphs are given from which it is possible to determine the acid loss. It was found that the acid loss normally ranged from 40 per cent. to 60 per cent. The two main causes of acid loss are (a) drag-out on the articles, and (b) the free acid present in the spent bath. In order to minimize acid loss, the iron content in the spent pickle solution must be as high as possible and the free acid content as low as possible. The acid concentration during pickling does not affect acid loss greatly, provided that the volume of the drag-out loss is not more than about 40 per cent. of the volume of the freshly-prepared bath. The pickling time for different acid strengths was determined at temperatures of 5, 15 and 25°C., using hot-rolled steel strip. The results indicate that iron chloride in the pickle solution has a favourable effect on pickling time, especially at higher concentrations and lower temperatures. The effect of an increase of free acid content in the pickle above about 100 gm. per l. is not so marked at 25°C. as it is at 5°C. The use of a commercial inhibitor in the pickle had no effect on pickling time. Small amounts of zinc in solution in the pickle resulted in an increase in pickling time by about 10 per cent. The solubility of iron chloride has been determined for different acid concentrations at 5, 15 and 25°C. The maximum iron chloride content of acid of strength 145 gm. HCl per l. is about 240 gm. $FeCl_2$ per l. at 5°C. and 290 gm. $FeCl_2$ per l. at 25°C. Thus in practice, the pickle can be worked down until the $FeCl_2$ content is 240 gm. per l. in a cold bath and 290 gm. per l. in a bath at 25°C. or warmer, without affecting pickling time.

In order to use the hydrochloric acid as economically as possible, it is necessary to analyse the pickle regularly. To obtain a reasonable pickling time, it is advisable to maintain the temperature at 20°C. or higher, so that the acid concentration can be held between 100 and 150 gm. HCl per l. For practical reasons, pickling temperatures should not exceed 40°C. At 20 - 30°C. the free acid content in the spent pickle can easily be worked down to about 60 g. HCl per l. or lower.

Thus, using the pickle bath in this way, acid savings of up to 20 per cent. can be obtained.

The behaviour of Molten Fluxes for the Hot Dipping process in Zinc, Tin and Lead

J. HILLE and W. DURRWACHTER

(Badische Anilin u. Soda Fabrik A. G.)

THE kinematic viscosities of some molten fluxes used in hot dipping processes have been investigated using a slightly modified Kampf viscometer. The anomalous thixotropic viscocity of zinc chloride disappears on addition of alkali halides (NaCl, KCl or LiCl). The viscosity of zinc chloride is thereby lowered considerably, the lowest viscosities being obtained with additions of KCl.

In systems containing ammonia the viscosity depends very largely on ammine formation and on the ammonium chloride content. Zinc ammino chloride was found to have a very low viscosity that is almost independent of shear stress. The influence of ammines on fluxes is similar to that of alkali chlorides, but the former are chemically and thermally less stable.

In all the cases examined oxides were found to increase the viscosity of fluxes when the solubility of the oxide in the melt was exceeded. The influence of iron oxides was found to depend upon the degree of oxidation of the iron. Iron ammino chlorides may be formed in a similar way to zinc ammino chlorides, but are useless as fluxes and, in galvanizing, lead to increased dress formation.

This paper is the first attempt made to study the behaviour of different fluxes ; further work is needed on aqueous systems and on the influence of frothing agents and other additions.

The reclamation of Hydrochloric Acid from spent pickle liquors

R. HAARMANN
(Siegener A. G.)

FERROUS chloride formed during pickling is precipitated from the spent pickle by adding hydrochloric acid gas and cooling to 0°C. in a separate vessel. The crystals thus formed are separated from the solution in a centrifuge, and the liquor is enriched and used again. The ferrous chloride is then thermally dissociated into hydrochloric acid gas and iron oxide, the gas being fed back into the first stage of the regenerating process. The rate of deposition of ferrous chloride in the crystallizing chamber is dependent on the rate of formation of hydrochloric acid gas in the roasting oven, so that the process may be regulated by setting a flow meter.

Data from two Ruthner plants indicate substantial gains for this reclamation process compared with neutralizing spent acid and discharging it. For Plant A pickling 3,000 tons of steel per month, the estimated saving is 120,000 DM per year. For Plant B pickling 6,000 tons of steel per month, a saving of 303,580 DM per year is made. These figures indicate that the larger the plant the more justified is the regenerating process. The smallest throughput for which it would be worth while at present is one of about 1,000 tons of steel per month.

A further advantage of the process is the greater control over the pickling process resulting from the constant acid strength.

DISCUSSION

MR. W. L. HALL (General Galvanizers Ltd.) said that in his paper Mr. Sjoukes had very rightly pointed out the importance of reducing acid losses and had quoted quite startling figures for the amount of acid which was being lost in certain plants. However, if washing was not done after pickling, but the articles went straight from the hydrochloric acid pickling to the galvanizing bath, the acid carried over on the work was not lost ; it was, of course, an essential chemical in the fluxing of the article as it went into the galvanizing bath. While, therefore, he would agree that it was essential to drain the articles properly to prevent acid carry-over, the acid loss might not be quite so large as had been suggested.

The question of chemical composition and control was mentioned in the paper, and was most important. He understood Mr. Sjoukes to maintain that fairly frequent analyses were necessary. It was Mr. Hall's experience that, when pickling in fairly large pickling tanks, the composition changed very slowly, and, although chemical analysis and control were necessary, and certainly useful, analyses made perhaps once every two weeks only would provide a good deal of information for the control of the plant.

The heating of pickling acid was also referred to in the paper. It was obvious that there were technical advantages to be obtained by using hot acid, and there were means, by proper heat exchangers, to do this without diluting the acid ; but he wondered whether adequate methods were yet available for control of the fume which came from warm hydrochloric acid. Control of the fume under certain weather conditions was often difficult when the acid was cold, and when pickling articles which did not lend themselves to the use on the surface of the baths of oil or other methods of suppressing fume. He would be interested to hear whether or not any other members of the Conference had solved the problem of finding an economic method of removing the acid fumes from the pickling area, especially when using large pickling baths, which might be up to 9 ft. in width.

Turning to Dr. Haarmann's paper, Mr. Hall said that to carry out this process described, though technically sound and basically simple, would be quite a difficult undertaking for the average galvanizing works.

He noted that the amount of acid necessary to make it an economic proposition was fairly large ; figures of 2,000 to 3,000 tons of steel pickled per month had been mentioned. Did Dr. Haarmann think there was any hope for the smaller works, pickling perhaps 800-900 tons of steel a month ? Was an economic process using this method likely to be developed for works of that kind ? The process might require a good deal more in the way of specialized labour and supervision than had been suggested, and the cost would therefore be a little greater. It would be interesting also to have some idea of the space occupied by such a plant.

DR. R. HAARMANN replied that according to the information in his possession the process at present was suitable for plants pickling 2,000 to 3,000 tons steel per month, but probably later it could be adapted for smaller plants. As he had already said it was more economic for continuous plants ; for the ordinary galvanizer it might appear to be rather complicated and might be regarded as if it were a small chemical works, but he did not believe that when experience was gained it would present many difficulties for the workmen. So far as the size of the plant was concerned, it could if necessary be made long and high but narrow, though he could not give any figures. The installation at his works occupied a space of about 20 x 8 metres.

MR. A. ASH (Fredk. Braby & Co. Ltd.) said that the plant described in the paper might be too costly for the small galvanizer, but it might be worth considering the installation of such a plant in conjunction with other galvanizers in the area.

He would like to ask a few questions about the Fe_2O_3 produced as a by-product from the process.

Dr. R. Haarmann replies to a point in the discussion of his paper.

What was its size and shape ? Was it suitable for use in powder metallurgy ? Was it suitable for the desulphurizing of coal gas ? Could it be sintered or nodulised for use in the ironmaking industry ?

DR. R. HAARMANN replied that the iron oxide was in the form of powder for which his company had already tried to find uses, but so far their experiments had not been successful.

DR. W. DURRWACHTER (Badische Anilin u. Soda Fabrik A.G.) suggested that since acid was necessary to regenerate the aryl ammines sometimes used in ion exchange processes, there was no real gain. What were Dr. Haarmann's views ? With regard to the Ruthner process, he wished to know how much iron chloride was extracted from the pickle in relation to its total iron chloride content — i.e., how much iron chloride was left in the treated acid.

DR. HAARMANN in reply said that the acid circulated continuously with the exception of the chloride from the HCl which went to form the $FeCl_4$. For this compound there was little commercial use. He had only mentioned the ion exchange as a possible method of dealing with pickle acid.

In the Ruthner process the iron chloride content of the acid depended on the throughput, on the recirculation time and on the extent of cooling. It was particularly important to control the $FeCl_2$ concentration in wire galvanizing, since pickling time was very sensitive to changes in concentration. This would not apply in general galvanizing.

MR. MORGAN H. DAVIES (Zinc Development Association) said that Dr. Haarmann had presented some very interesting information about the Ruthner process, but it might be of interest to the Conference to hear something about another regenerative process which was being developed, a single-stage process which depended on the feeding in of spent pickle continuously into a tall column, where it was atomized at the top. At the base of the column were tangential injection burners, and the hot exhaust gases passed up the column and vaporised the water and HCl from the plant acid. The particles of Fe_2O_3, if coarse, fell down to the base of the column or, if fine, were taken on with the exhaust. The water vapour and hydrochloric acid gas were then absorbed in a counter-stream column, giving acid of 13 - 14 per cent. strength which could be used directly once again. It was contended that the plant could be made fully continuous and that the recovery of the acid was about 90 per cent.

At the present time information was available only on the operation of the pilot plant, which dealt with 20 - 25 gal. per hour. That pilot plant had been operating for about two years. For commercial plant it was felt that something like 100 gal per hour could be dealt with on an economic basis, going up the scale to about 250 gal. per hour. The plant would then cost about £25,000 and would regenerate acid at 50-70 per cent. of the cost of commercial acid.

Mr. Ash had already pointed out that in the United Kingdom it was not merely the treatment of the acid from the economic point of view which was important, but its treatment from the point of view of effluent disposal. In the United Kingdom they would have to consider the merits of these processes on more than a simple economic basis.

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Session III

RELATIVE MERITS OF WET AND DRY GALVANIZING

Chairman : MR. R. GLOOR
(A. G. Kummler und Matter)

Survey of Galvanizing Processes

E. C. MANTLE and P. HOESLI
(British Non-Ferrous Metals Research Association).

WITHIN the galvanizing industry there is still considerable discussion about the merits of the various galvanizing processes in current use, particularly the effectiveness with which the different processes make use of zinc. A survey of the main galvanizing processes with the co-operation of about twenty member firms has therefore been carried out.

The main processes of galvanizing in current use are : the dry process ; the old dry process (in which the work is pickled and the pickle salts are dried on to the work, the work then being dipped into a clear galvanizing bath); the wet process ; the modified wet process (the work being rinsed and pre-fluxed before entering the galvanizing bath through the flux blanket).

The industrial survey that has been carried out has produced some surprising results. The figures collected suggested, for example, that for galvanizing articles such as tanks and cylinders and work of similar weight, the old dry process makes more effective use of zinc than either the modern dry process or the wet process. Whereas the old dry process would be expected to produce much larger quantities of dross than the modern dry process, dross production recorded by the firms working this process is for the most part no greater than that of the firms working the modern dry process. This strongly suggests that the particles of iron-zinc compound formed by reaction between the molten zinc and the iron salts arising from pickling are retained as part of the coating instead of falling away into the bath and forming dross. For hollow-ware galvanizing, the wet process appears to be remarkably efficient, though it is open to the objection that there is a danger of flux staining and the possibility of corrosion from flux residues.

Flux consumption was found to vary considerably from plant to plant, bearing little relation to the galvanizing process in use. It is obvious that some plants manage to carry out their galvanizing using far less flux than others working the same process and doing similar work. In many of the plants the cost of the flux used exceeded 5 per cent of the cost of the zinc consumed so that flux consumption is a not inconsiderable item of galvanizing costs.

The dry galvanizing process involves more stages than either the old dry process or the wet process and might be expected to use more labour, but there is no suggestion from the results of this survey that that is so. The output of work per man hour varied tremendously from plant to plant even when the plants were handling the same type of work, and is clearly a function of the organization of the plant rather than the galvanizing process used.

Survey of Galvanizing Processes with Particular Reference to the Efficiency of the Use of Zinc

H. Bablik
(Brunner Verzinkerei Brüden Bablik)

THE essential factor in dry and wet galvanizing is by no means whether articles enter the bath with an apparently drier or wetter surface, but *only* whether the zinc bath is alloyed with Al or not. This, and only this, is the ruling factor. The reaction between iron and zinc, which leads to the formation of the Fe/Zn alloy layer, is determined by the Al addition which essentially depends for its extent on the time of immersion of the article in the bath, the bath temperature and the property of the iron. Dry galvanized coatings, correctly applied, have, therefore, *no* alloy layers. A coating produced by dry galvanizing, owing to the absence of an alloy layer, if correctly applied, is considerably thinner than that produced by wet galvanizing. It should, however, be emphasised that, insofar as it has been produced in a bath correctly alloyed with Al, it consists essentially of the pure zinc layer only.

Apart from zinc losses caused by skimmings and dross, zinc consumption depends above all on :—

(a) The correct concentration of Al in the bath. In average conditions this can be taken as 0.1 to 0.15 per cent Al ;
(b) On the properties of the iron base ;
(c) On the immersion time, since this determines the thickness of the Fe/Zn alloy layer. Since the Fe content of the Fe/Zn alloy layers is on an average between 6-8 per cent, and the remainder consists of zinc, the Zn consumption is fairly shown by the thickness of the Fe/Zn alloy layers.

Zinc consumption can be correctly judged and estimated only if we consider the thickness of the Fe/Zn alloy layer i.e. whether it is nil, and so completely absent, or to what extent it has been allowed to grow by immersion time ; but immersion time is actually pre-determined by the shape of the articles, and partly also by their sheet thickness. A reasonable comparison of zinc consumption, as between dry and wet galvanizing, is therefore only possible if this point of view is also taken into consideration. It is obvious that, in view of the thinner layer in the case of dry galvanizing (but again neglecting skimmings and dross), zinc consumption must in all cases be less in dry galvanizing ; but reasonable statements on zinc consumption in dry galvanizing are only possible if, at the same time, the Al content of the zinc bath is stated.

Wet and Dry Galvanizing

To differentiate between dry and wet galvanizing, by the manner in which the flux is applied, whether it is dried upon the surface of the article — dry galvanizing — or whether it floats on the surface of the bath as a fused salt, in which case the articles enter the bath with a wet surface — wet galvanizing — is only a question of outward appearance, which in any case is easily observable to the naked eye, On the other hand the Al content of the bath can only be ascertained by analysis. Here, spectrographic determination is the most suitable means. It must not, however, be forgotten that it is precisely this Al content of the bath which compels the galvanizer to apply the flux to the surface of the article. Undoubtedly dry galvanizing entails higher costs, and is, if properly carried out, a process that requires more care than wet galvanizing. The surface of the article must be cleaned by washing, since the flux, as used in dry galvanizing, is much less active than it is in wet galvanizing. The use of the dry process is therefore only logical when easily formed zinc coatings are required, since, owing to the absence of the Fe/Zn alloy layers and the generally thinner layer, these coatings are far more easily formed than those produced by wet galvanizing ; but being thinner, have a much shorter life, since the protection against corrosion is roughly in linear proportion to the coating thickness, Thus, if there is no need to produce easily formed coatings, or if thinner coatings are unacceptable, dry galvanizing should not be employed.

Proper dry galvanizing with the correct Al additions has been developed for sheet galvanizing which requires coatings that will stand bending. It was not long before this working procedure was used for other types of galvanizing, *e.g.*, for hollow-ware. However, in the case of hollow-ware, thicker coatings have to be produced than in sheet galvanizing since attack from alkaline domestic waters is far more severe than it is from the atmosphere. In hollow-ware galvanizing therefore, there has been a change towards smaller Al additions in the bath which has led partly to making it impossible to analyse the Al content exactly, and has partly given rise to the idea that the inhibitive effect is in some way proportional to the amount of Al added. This is by no means the case.

Critical Aluminium Content

It is not until a critical Al value is reached that the thickness of the alloy layer suddenly decreases. The thickness of pure zinc layer depends in general on the viscosity of the bath and the speed of withdrawal and has, on coatings containing an alloy layer, a thickness of about 35μ, and on coatings where no iron zinc alloy layer is present, of about 20μ. The consequence of this is that it is not possible to control the coating thickness by means of Al content alone.

It is this Al content in the bath which necessitates the use of a flux of the kind customarily used in dry galvanizing. If a bath contains about 0.1 per cent Al, no chloride-containing flux cover will remain stable on it. The metallic Al is removed from the bath by conversion into aluminium chloride which evaporates at 123°C., or by the aluminium chloride ammine which is formed and which also evaporates. Furthermore, hydrolysis of the $AlCl_3$ leads to the accumulation of corundum in the flux cover. This is no longer dissolved from the flux and the flux cover becomes crumbly and ineffective. By these reactions, both the Al is removed from the bath and the flux cover is destroyed. In order to stop the process of these reactions, fresh and unused flux must therefore be applied on every surface of the article. This is done by immersing the articles in an aqueous solution of the flux which dries on them. The surface appears dry to the eye, although it still holds a lot of water ; and it is from this easily recognizable appearance that the whole process has received the name of " dry galvanizing," although the really correct description would be " galvanizing in a bath without Al or with 0.1 per cent Al."

Removal of Iron Salts

Apart from this, the effect of the flux as a solvent of pickling residues deserves mention. The more noble metals are displaced from their compounds by less noble metals both in aqueous solutions and also in fused salts. Insofar as iron salts are retained on the surface of articles, as soon as these salts come into contact with zinc, the following reaction takes place :—

$$FeCl_2 + Zn \longrightarrow ZnCl_2 + Fe$$

$$Fe + Zn \longrightarrow Fe/Zn \text{ (hard dross).}$$

Thus if the washing has been insufficient, the retained iron salts lead to an increase in hard dross. In order to avoid this, the intelligent galvanizer, before immersing the article into the zinc bath, gives it a flux wash.

The figures for formation of hard dross can therefore only be rightly understood in their relationship, if at the same time attention is paid to :—

(a) the type of iron (C, Si content, surface property) ;
(b) immersion time and temperature ;
(c) effectiveness of washing treatment.

The relative zinc consumptions of dry and wet galvanizing can therefore be determined with accuracy by purely theoretical considerations on closer examination.

The important point is whether there has been sufficient washing
(a) with water
(b) with a correctly concentrated flux wash.

If the iron salts are removed, the amount of hard dross will be less. Moreover, the amount of hard dross can be lessened in wet galvanizing by suitable types of iron, suitable immersion times and suitable immersion temperatures. However, the most important decrease in zinc consumption is obtained by correct alloying of the bath with Al, which leads to applying a flux treatment known as dry galvanizing. The use of dry galvanizing without the correct alloying with Al seems hardly sensible.

As a result of the absence of Fe/Zn alloy layers, the zinc consumption is in every case less when dry galvanizing is correctly carried out, but the zinc coating is also in every case thinner. In dry galvanizing it is simply the occurrence of ash that is somewhat greater than in wet galvanizing ; but, zinc consumption is significantly less in correct dry than it is in wet galvanizing ; but in dry galvanizing the coating is thinner.

A Survey of Galvanizing Processes and a Comparison with West German Results

K. LEWUS
(Gemeinschaftsausschus Verzinken)

Dross Formation

A COMPARISON of the maximum dross formation of the two groups listed by Mantle and Hoesli reveals the remarkable fact that all these plants use coke heating. From this it can be concluded that the high dross formation is principally dependent on this type of heating. Since the working temperature is not given for four of the coke heated pots, it is possible that these baths were at times over-heated owing to defective temperature control. It is equally probable that the high dross formation is also attributable to stronger local attacks on the pot wall due to irregular heating.

The determinative influence of the type of heating on dross formation is also clearly shown by the two electrically heated pots listed, in which relatively little dross arises, thanks to the regular heating and in spite of the wet galvanizing process employed.

The amount of dross arising from the pot depends not only on the type of heating, but also on relative throughput. The lower the throughput the higher, under normal working conditions, is the amount of dross formed in proportion to the total amount. According to experience in Western Germany, this part amounts to about 15 to 20 per cent of the total amount of dross formed. In individual cases, however, it may be considerably higher, and must no longer be neglected in calculations.

Given regular heating and normal throughput, assuming an annual decrease of 3 mm. in the thickness of the pot wall, then about 50 kg. of dross occur per month per sq. m. of pot wall. Proceeding on this assumption, leads to the conclusion that the proportion of the dross formed by the pot walls lies somewhere between 20 and 25 per cent in most of the 17 plants studied. In the case of 6 plants of medium size and 1 heavy plant, the estimated amount is even about 40 per cent and over.

Zinc Coating

A surprising result of the examination is the high zinc coating in dry galvanizing as compared with the other processes. This difference is shown most strongly in the hardware galvanizing group. Here, the average zinc coating amounts to 1.8 oz. per sq. ft. for dry galvanizing, and 1.3 oz. per sq. ft. in wet galvanizing, corresponding to 550 and 400 gm. per sq. m. on one side of the surface. The West German hardware galvanizers, on the other hand, produce zinc coatings lying between about 300 and 350 gm. per sq. m. and here dry galvanizing shows the lower figures. So far as can be seen, the remarkable difference in practical results between British and West German dry galvanizing lies in the different ways of alloying the bath with aluminium. The British baths contain, by preference, only a small aluminium content, or even none ; while bath contents preferred for dry galvanizing in West Germany use about 0.15 per cent. aluminium. by which means, using short immersion times, the formation of the iron-zinc alloy layer is considerably inhibited.

The highest amount of alloy in the bath is used in a plant galvanizing by the Liban process, and using 1.025 per cent aluminium. In consequence of the high aluminium content in conjunction with longer immersion periods for difficult unwieldy parts, inordinately thick zinc coatings are produced. The results of this process should not, therefore, be taken as a standard for wet galvanizing. On the other hand, it is shown that a plant using wet galvanizing, is able to turn out thinner

zinc coatings than the other plants of the heavy group which use dry galvanizing or the old dry process.

The high zinc coatings quoted by Mantle and Hoesli are estimated and apparently have not been tested by measurement of coating thickness. According to the paper, the excessively high zinc coatings quoted, may be attributable to errors in the estimation of the wall thickness of the articles galvanized and to neglect of edge surfaces, and possibly they also express zinc losses due to splashing, dripping or waste.

Fluxes

The use of fluxes is surprisingly high with the exception of two plants, one of which, in dry galvanizing hardware, uses 2.4 kg. per ton throughput in ammonium chloride and zinc chloride together, and the other which in the old dry process requires only 1.6 kg. per ton of ammonium chloride for scattering on heavy articles. The very high consumption in some of the other plants is certainly to be attributed to inexpert use of the fluxes and should be far less in connection with the galvanizing process. By way of comparison the standard consumption figures for fluxes in West Germany are in dry galvanizing, 1-3 kg. per ton, and 3-5 kg. per ton in wet galvanizing and/or the old dry galvanizing.

Labour Required

The paper reveals a high figure for auxiliary labour which on the average is as high as that for galvanizing. It is probably that the largest part of the auxiliary labour is employed for transport and subsequent work on the articles galvanized. In West Germany the proportion of auxiliary workers to galvanizers is about as 1:3 up to 1:6.

Correspondingly, the total cost in working hours per hundred tons of throughput is partly considerably lower, as shown by the following comparisons :

	West Germany	England	Average
Hardware Group	1000-2000	828-3175	2100
Medium Group	500-1000	910-2040	1500
Heavy Group	400- 800	624-1540	1000

The greater use of auxiliary labour is not expressed in a better use of the zinc bath. While in West Germany one can count on an hourly throughput of about 20 kg. per ton zinc bath content, only a few of the British plants examined reach this performance.

DISCUSSION

MR. J. R. ROUFF (Association Technique de Galvanisation), dealing with the paper by Hoesli and Mantle, said that for a factory in the same category as one quoted in the paper, working in the same conditions and doing the same type of work, it had been found that for zinc of 98.5 per cent purity there was a dross production of 2.8 per cent whereas for 99.5 per cent zinc there was a dross production of 1.6 per cent. It was a function of the tonnage treated, so that the use of better zinc quality reduced the dross production by 45 per cent.

MR. G. R. FAULKS (John Williams & Sons (Cardiff) Ltd.) said that Dr. Bablik's paper took their minds back to the Copenhagen Conference in 1950, when the problem of wet *versus* dry process had first been raised. One of the practical points which arose, to his mind, was whether galvanizing was carried out to prevent rust or with the idea of bending or forming the material galvanized. In some of the illustrations in the papers the thickness of the zinc protection had been shown to be very thin indeed, and it seemed to him that one of the questions which galvanizers in the United Kingdom had to face was the need for a better coating of zinc.

Using the Sendzimir process in his own works they had used a lot of sheet material for forming with bends up to 90 deg. and had found these coatings very dangerous. They had actually found them rusting in the shop before the material had been despatched, due to cracking on the outside of the bend. That had made things extremely difficult for them, and they had had to protect the zinc coating by paint. Everyone wanted zinc efficiency, but it must be realised that the real function of galvanizing was to prevent rust. Anything less than 2 oz. per sq. ft. was unsatisfactory.

Dr. Bablik had also said that it was not until a critical aluminium value was exceeded that the thickness of the alloy layer suddenly decreased. It was extremely difficult for the practical galvanizer to keep the aluminium at its proper percentage in the bath. The dry process improved the conditions in the shop so that it was much more pleasant to work in, and, in spite of perhaps a lower zinc efficiency, it was a most efficient process.

MR. R. SOUSKE (Zinc et Alliages) said that it was possible to determine the aluminium by other methods than the spectrographic, which had the drawback that the figures obtained were not so precise as those obtained by the photometric method used by his firm. This had been used in dealing with zinc of different qualities with impurities up to 2 per cent., and the figures obtained corresponded exactly with those found in the galvanizing bath. The method had only recently been introduced, but had been used with success to deal with impurities in the zinc.

MR. W. L. HALL (General Galvanizers Ltd.) said that it was very difficult to analyse the data obtained from a number of galvanizing plants, because even if some attempt was made, as had been done by Hoesli and Mantle, to classify them, there would still be great divergencies. What one plant regarded as heavy work might be regarded as light work elsewhere, and so on.

It might be of interest on some future occasion to try to carry out a comparison on the basis of the costs of operation, including, of course, the whole range of factors which made up galvanizing costs. It might be possible to do this without disclosing the identity of the plants concerned or enabling the costs of individual plants to be dis-

cernible from the final results. It seemed to him, however, that only if that were done would it be possible to get the ultimate answer that management might want, which was whether it cost more or less to galvanize by a given method.

He would like to underline the point already made concerning the influence of what was called in England the dry process, which he realized was something entirely different from the specialized process to produce ductile coatings to which Dr. Bablik referred. What was called in England the dry process certainly did improve working conditions ; and, in view of the difficulty, especially with wide galvanizing baths galvanizing large articles, in carrying out proper fume extraction at the bath, it seemed to him that there was a great advantage in the dry process in reducing the fume present in the shop and so making it possible to improve working conditions. That sort of thing could not be measured in terms of money, but it might be very much cheaper to use a dry process, which would be less efficient from the point of view of zinc economy but avoid the use of a good deal of expensive equipment needed to remove the fumes from a very large bath.

AUTHOR'S REPLY

MR. E. C. MANTLE, in reply, said that it seemed to him that Dr. Bablik on the one hand and he himself and Mr. Hoesli on the other were talking about two entirely different matters. It was clear that there was a difference of opinion over the definition of "wet" and "dry" galvanizing between England and Germany, and that what was meant in England by "wet" galvanizing (galvanizing through a flux blanket) and "dry" galvanizing (galvanizing without a flux blanket) was quite different from what Dr. Bablik referred to when he talked about dry galvanizing with a bath containing a substantial amount of aluminium. The authors were well aware of the properties of the coatings obtained when large aluminium additions were made to the galvanizing bath, and this had been dealt with in a paper at an earlier Conference.

There were some practical considerations in connexion with the use of these baths on which he would be very interested to have information. For example he believed that with long immersion times in these high aluminium baths, which were recommended when handling complicated articles such as tanks or cylinders, there was a tendency for there to be a curious growth of the zeta phase of the alloy layer, which developed to very large proportions and gave a very rough and variable coating. He would be interested to know how that difficulty was overcome in practice. He had also noticed a tendency to have air patches with galvanizing baths of this type when very slow rates of immersion were used, and he would like to have information about that.

The contribution by Mr. Lewus they had found extremely interesting. Mr. Mantle was not sure that he agreed fully with Mr. Lewus's contention that coke heating was the cause of the high dross formation in some of these plants. It might be a contributory factor, but he did not think that it was a question of cause and effect. There were very many variables which might influence dross formation. He had done a rough calculation on the basis of the attack on the pot wall which had been referred to, 3 mm. a year. That was equivalent to about 1/150th ton per sq. ft. pot wall per month, and in the case of some of the smaller pots, 10 x 4 x 4 ft., that would produce about ¾ ton of dross per month, whereas these pots might produce something of the order of 3 tons of dross per month. In the case of some of the larger baths, for structural steelwork, the dross production would be about 1¼ tons per month from the pot wall, whereas the plant to which Mr. Lewus had particularly referred, produced about 19 tons of dross per month.

Mr. Rouff had maintained that dross production was dependent on the zinc quality. That was something which the authors had not included in the survey, because they had felt that they had sufficient variables to contend with without it. The plants would all be using zinc with 1 per cent of lead and nominally 98 per cent of zinc, though he thought that the zinc content would generally be higher than that. So far as Mr. Mantle could see, the main factor in zinc quality which would affect dross production was the iron content of the zinc, and this would be very low.

Mr. Hall's contribution emphasised once more a point which Mr. Mantle had made in introducing the paper, that apart from the question of zinc economy there were other things to consider, including working conditions. It was obvious that the dry process as they knew it had many advantages from that point of view, and that alone might make it much more attractive than any other process. Mr. Hall had also suggested that someone ought in the future to consider the question entirely from the economic point of view and compile statistics about the cost of galvanizing in different plants. The authors agreed that that would give very interesting results, but it would make it difficult to compare the efficiency of different processes, because there were tremendous differences in the amount of labour used by plants apparently doing the same job and operating the same process, and that would have a bearing on the economics of the working of the different plants.

Session IV

BATH HEATING

Chairman: MR. C. P. H. WEDGE

(B. E. Wedge Ltd.)

Oil-Fired Galvanizing Baths

J. G. C. POPE

(The Shell Petroleum Co. Ltd.)

THE use of oil-firing by galvanizers has increased rapidly in recent years, and this can be attributed to a combination of economic and technical factors. The grade of oil used varies from the 100 per cent distillate to the heavy fuel oil blend of residual oil and distillate — the higher the viscosity, the cheaper the oil.

The thermal considerations in the design of an oil-fired bath are similar to those for other types ; the maximum rate of heat transfer through the walls should not be more than 10,000 B.Th.U./sq. ft./hr, or the pot may be adversely affected, and for this reason the flame from the burner cannot be allowed to impinge directly on the bath wall. The rate of heat transfer can be satisfactorily controlled by protecting the walls of the bath by a layer of brickwork ; by installing a refractory wall a few inches away from the bath, on to which the flame burns — the products of combustion can then be made to pass between this wall and the bath ; and by circulating the products of combustion round the bath from an external combustion chamber, after dilution with air or recirculated gases.

With the third of these systems, the gas temperature is so low that over-heating is virtually impossible, the setting design is simple and temperature control straightforward, since the amount of firebrick is kept to a minimum, and the cheaper grade of fuel is comparatively easy to use since the flow of heavy fuel oil may be more easily controlled to one or two burners than to a multiple burner setting.

Automatic control of temperature is a feature of all modern installations ; it is achieved by actuating valves in the oil supply line from thermocouples placed in the zinc, bath and in the flue system. The burners themselves may be of the high/low flame or the on/off type ; in both cases, the flow of oil to the burners is automatically regulated by the bath thermocouples, and in the latter re-lighting of the burner is also automatic.

Sufficient oil should be held in stock to keep the baths working for 2 to 3 weeks. Storage tanks are usually cylindrical, and should be installed a few feet above ground level for ease of maintenance. Gauges are necessary, and stand-by tanks minimize cleaning difficulties,

With all but the least viscous oils, heating facilities in the tanks are necessary, so that the oil will flow easily from the tank to the burners. The oil must be heated further just before the burners to ensure effective atomization, and line heaters are normally employed ; in large installations it may be worth while to circulate the oil through the ring main at burning temperature,

Low-pressure air, medium-pressure air and rotary cup burners are described. In galvanizing, a high turndown range is required to cover maximum working and stand-by periods, and it may be necessary to have at least two burners ; the large, rapid changes in heat requirement of the bath also make a firebrick lining to the setting valuable as a source of stored heat.

The operating efficiency of an oil-fired installation should be similar to that of a gas-fired plant, but the fuel cost of the former may be the lower by 30-50 per cent.

On the Use of Line Frequency Induction Furnaces for General Galvanizing

H. CHAPMAN

(General Steel Wares Ltd.)

A SMALL pilot plant of zinc capacity 1,700 lb. and surface area 20 in. x 20 in. was used for galvanizing small articles. The power is supplied by means of a simple transfer with a 490-volt primary coil, the secondary coil being a loop of zinc continuous with the zinc of the bath. The heavy induced current passing through the zinc causes it to be strongly agitated in both vertical channels. The entire installation is lined with refractory and is thus free from metal which would dissolve in the bath.

A wide range of operating temperatures can be used (427-527°C.) and no serious damage was caused by the zinc accidentally reaching its boiling point (907°C.) on one occasion. Both the wet and the dry galvanizing processes may be used with this type of installation. Aluminium additions of up to 0.28 per cent have been made ; when the aluminium content was more than 0.01 per cent. ash formation was negligible.

The formation of dross was also minimized, since nearly all the dross formed was kept in suspension by the strong agitation of the zinc, and was carried out of the bath on the articles dipped ; the amount of dross found in coatings was, however, satisfactorily small.

The coatings formed were thinner and more adherent than those found in conventional practice ; the aluminium additions suppressed the brittle alloy layer.

The induction furnace may eventually replace other types of bath, for its zinc utilization is very high due to small wastage in residuals.

The Top Heating of Galvanizing Baths

R. HAARMANN

(Siegener A. G.)

THE need for efficient bath heating in hot dip galvanizing has resulted in the development of induction heating and top-heating methods, coupled with the use of ceramic pots. Gas-fired, top-heated installations are described and compared with side-fired baths. The first example used to illustrate the method is that of a gas-fired wire galvanizing bath. Initially, the heating hood was located over one side of the bath, leaving the other free. Later designs (for higher output) involved placing the hood over the middle of the bath with wires passing on each side of it, or having the hood in two parts (each independently removable) covering the whole bath.

In comparing the top-heated bath (maximum throughput 500 kg./hr.) with a side-fired installation, it is shown that the no-load gas consumption of the latter is much the higher of the two. The consumption of the top-heated bath, however, increases almost linearly with throughput, while that of the side-fired bath is almost constant until the throughput exceeds 3 tons/day ; with higher loads, the consumption curves run parallel and close to one another, the side-fired bath having the lower consumption. Uniform temperature distribution was obtained at the working surface of the top-heated bath. Ash formation at the free surface depends on conditions and throughput as in normal practice. Under the hood, the ash built up to a constant depth of about 2 cm. without increase in gas consumption. The use of recuperators was discontinued because of fouling with zinc ash.

The second example is a bath with a maximum throughput of 1,250 kg./hr. its performance is compared with that of a side-fired bath of only one-fifth the zinc capacity. A fuel saving of 45 per cent was achieved with the top-heated bath for throughputs of about 1 ton/hr.

It is concluded that top-heating is not economically competitive with side firing for large throughputs, because of the excessive heating area required for heat transfer.

The main advantages of the top-heated bath lie in the almost unlimited life of the pot and in the very low rate of dross formation.

Electrical Bath Heating

A. PARENT

(Usine à Tubes de la Meuse)

A GALVANIZING bath (7.7 m. long, 0.8 m. wide and 1.2 m. deep) is heated by 120 electrical resistance elements placed in the molten lead jacket which surrounds the zinc pot. The installation is fully insulated.

120 elements are arranged in groups of four for control purposes and these groups are divided into seven "zones." Four thermocouples control the power supply.

Over a period of one year, for an average production of 3.1 tons/hour (of tube) the average power consumption is 115 kW per ton. In the stand-by period, with the bath covered, the average power consumption is 55 kW.

By comparison, oil-fired baths had consumptions between 2 and 3 times the electrically-heated pot for similar outputs.

The cost of electricity is high, but this is partly compensated for by other factors ; no personnel are required to supervise bath heating ; there is no storage or handling of fuel ; no maintenance for burners or flues is required ; heat transmission is higher and the uniformity of heating avoids hot spots leading to pot failure.

One bath after processing 14,553 tons of tubes showed a reduction of wall thickness of only 4 to 5 mm. on the long entry side of the bath which receives the most heat.

MR. J. G. C. Pope in presenting his paper said that town's gas and fuel oil had risen less in price than coal or coke in the last ten years.

On the basis of a heat input of 10,000 B.T.U.'s the figures given below were informative :

	100 per cent efficiency	60 per cent efficiency
Town's gas at 1/6 per therm	18d.	30d.
Coke £7 per ton	7d.	14d.
Electricity 1d. per unit	29d.	34d.
Oil at £12 per ton	7d.	11.6d.

At the present rate of fuel prices and bearing in mind the controllability and flexibility of an oil-fired installation, oil was an eminently suitable fuel for galvanizing.

A fully automatically controlled system was recommended by Mr. Pope and as an aid to combustion efficiency and hence fuel saving, he thought it advisable to analyse the flue gas from time to time to ensure that too much excess air was not entering the system.

Care should be taken with the lay-out of the oil tanks, pumps, and piping etc., and the major oil companies were willing to help with advice on these points if asked. They were also glad to help the user by providing information concerning the temperature at which any particular grade of oil should be stored and burnt to give the best results.

DISCUSSION

MR. G. PIPER (Nordic Circle of Hot Dip Galvanizers) commented briefly on the practical experience obtained in Sweden with four top-heated and three induction furnaces. One company had two baths, one for galvanizing nails and one for galvanizing wire. The top-heated nail bath contained 3 tons of zinc, with a capacity of 1⅛ ton per hour. This had been running two shifts a day since 1952 without any sort of trouble. It was sometimes necessary, of course, to change the heating elements, and this was done during servicing, from one side of the top. The blanket was of titanium dioxide and was changed every week, which took only a couple of minutes.

On average the dross and ash formation were lower than with a normally-heated bath. The wire pot had been used only for shorter periods, but the company were very satisfied with these types of heating the galvanizing bath.

Another company had a bigger furnace which was heated by oil and had had some trouble with the brick lining of the top, and the heating efficiency was not so good. A heating efficiency of 85 per cent for electricity had been referred to. He thought that it was rather higher for electric heating, but that with oil heating it was not so high as 50 per cent. On the whole furnaces of this type were constructed for electric heating, and in Sweden the view was taken that oil heating for this type was not so good.

Another Swedish company, which was galvanizing refrigerating units for domestic refrigerators, had two induction-heated baths. One was six years old and 60 kW, and the other two years old and 100 kW. Both baths were now run on the dry process, with automatic pickling in sulphuric acid and fluxing and drying in the usual way. The aluminium content of the bath reached 0.2-0.3 per cent and the average dross formation was only 5-6 per cent. This company was very satisfied with this type of bath.

MR. C. VAN KEMPEN (Johan Vis & Co. N.V.) said that it was stated in Mr. Pope's paper that with heavy oil it was advisable to burn the oil completely in a separate combustion chamber before mixing with the returned gas. In Mr. van Kempen's furnace the mixing was done round the flame in the combustion chamber without any trouble whatever.

Mr. Pope had also stated that a firebrick lining had the advantage of acting as a "heat flywheel." In Mr. van Kempen's view this was a disadvantage of the brick lining, because it meant that the reactions were slowed down, and when running the furnace to maximum capcity there was the danger during a meal break, for instance, of overheating.

Mr. J. N. Park (Thompson Bros. (Bilston) Ltd.) commenting on Mr. Pope's paper on oil firing, referred first of all to costs and said it was a pity that at the present time they did not have any costs on oil-fired galvanizing plants, but from some figures which he had seen it appeared that, on a pure fuel basis, oil firing was perhaps 30-40 per cent cheaper than town's gas. Although coal was relatively cheap in the United Kingdom, and on a fuel basis comparable with oil, there were certain labour charges which must be taken into account when firing by coal.

That figure of a 30-40 per cent reduction with oil as compared with town's gas had a big bearing, he felt, on the final cost of the galvanized article, and it would be helpful if a survey of costs by oil firing could be made. Mr. Park believed that this would show an overall decrease in the cost of galvanizing in the region of 2½ per cent.

Ancillary Costs of Oil Firing

Mr. J. Leutbecher (Walter Korner G.m.b.H.) said that everyone was interested in seeing that the heaviest oil was used, but it was necessary to take into account the fact that the ancillary installation necessary for the heating of heavy oil was costly so that in many cases for this reason a light or medium oil was used. For heavy oil, in his own experience, the limit lay at about 100 kg. of oil per hour, and this was possible when several galvanizing plants could be fed from one oil installation. In the case of new installations with oil-fired pots the initial capital cost had to be taken into account. The fact that no such extra cost was incurred when electric heating was used might often make good the difference in the price.

Mr. J. Bradbury (The Incandescent Heat Co. Ltd.) referring to circulation rates round galvanizing baths said that with regard to the figures quoted in Mr. Pope's paper for the recycling fan handling 10 to 20 times the weight of gas produced from the burning oil, in recent installations his firm had increased this to 30-40 times with advantage. Circulation velocities were also of extreme importance in bringing down the temperature of the gases and increasing the rate of heat transmission through pot walls. The flow of gas round the pot had now been stepped up to something like 85 ft. per sec., and they were talking in terms of gas temperatures round the pot of 500-550°C., with working temperatures of the order of 460-465°C.

On the question of the cost of operating on oil firing he could quote figures for the circulation type of bath. In a recent installation which was just going into production, 14½ ft. long, 4½ ft. wide and 11 ft. deep, for dipping window frames, the standby losses, holding the bath at 450°C., were of the order of 4 gal. per hr., while for a production rate in the region of 1 ton 13 cwt. per hr. the figure was of the order of 7.2 gal. per hr.

Mention was made in the paper of the use of firebrick and high temperature insulation brick. The first was a heat storage medium which galvanizers in general did not require, while the other, from the point of view of circulation systems, was unfortunately permeable and allowed the heat to travel through and get back on to the casing. To overcome this a special concrete mix had been developed which reduced the number of joints through which gases could leak and also gave what was virtually an impermeable surface to the brickwork structure. In terms of heat loss around the structure this type of concrete was very satisfactory.

He recommended to galvanizers the use of burners which were self-proportioning, where the oil/air ratio remained constant, having been pre-set.

* * *

Session Va

COMPARISON OF GALVANIZING PROCESSES

Chairman: Dr. R. Haarmann

(Siegman A. G.)

Comparison between the Cook-Norteman and Sendzimir Processes — 1

by H. Bablik

(Brunner Verzinkerei Brüder Bablik)

Some of the features associated with continuous strip galvanizing — such as the use of exit rolls and aluminium additions to control coating thickness — originated in traditional sheet galvanizing practice but the significant factor in continuous methods is the heating arrangement which allows high throughput to be achieved.

In the Sendzimir process heated strip enters the bath and in the Cook-Norteman, induction heating using ceramic pots is employed. There is a marked difference in capacity, however, the larger Sendzimir installations having a maximum throughput of about 20 tons per hour, whereas in the Cook-Norteman process 50 tons per hour can easily be achieved.

Tests were carried out on samples of similar chemical composition from twelve firms (ten using the Sendzimir process and two the Cook-Norteman process). No significant differences were found in the chemical composition of the basis steel, or in the grain size, distribution of carbon, or inclusion content. The mechanical

properties of galvanized strip produced in both types of plant were similar, but the yield and tensile strengths were somewhat higher than galvanized hot rolled sheet and cold rolled strip produced in Central Europe. The deep drawing properties were found to be variable and dependent on the history of the steel rather than the galvanizing process. A detailed examination of the coatings shows that the power driven exit rolls employed in the Cook-Norteman process give rise to greater variations in the coating thickness than those obtained in the Sendzimir process. The necessity of controlling the aluminium content of the bath in order to restrict alloy formation is emphasized and determination of the iron content in the coating as a means of control in the Cook-Norteman process is considered unsatisfactory. The turbulence in the induction heated bath causes dross to be retained in the outer zinc layer affecting the analytical control and also concealing the amount of dross actually formed in the bath.

The causes of uneven coatings and of the groove patterns obtained, particularly on Cook-Norteman type strip, are discussed together with an examination of the geometrical effects due to the position of exit rolls relative to the zinc surface.

No differences in the bend properties of Sendzimir and Cook-Norteman strip were found ; microscopically fine cracks observed after severe bending depend on the orientation of the zinc crystals but no flaking occurs in bending strip over its own thickness. Alloy layers not greater than 5μ thick are necessary to ensure good bend properties. The spangle size of Sendzimir strip is considerably larger than Cook-Norteman strip but it is not known whether this has any influence on formability.

While the relatively rapid tarnishing of continuously galvanized strip is associated with the presence of aluminium in the coating, marked staining of Cook-Norteman strip also results from incomplete removal of flux residues.

Comparison between the Cook-Norteman and Sendzimir Processes — 2

by T. SENDZIMIR

(Armco Internation Corporation)

IN the Cook-Norteman process one of the advantages claimed lies in the circulation of aluminium, making the bath more consistent by constant mixing, as a result of using a low-frequency induction method for heating, whereas in the Sendizmir process the aluminium stays near the top. That, however, is where it needs to be so as to be available in proper concentration at the moment when the strip makes the first contact with the zinc. In the Sendzimir process aluminium is added in the form of a zinc-aluminium alloy in small quantities and very frequently. If for any reason it is necessary to change the analysis, it can be done in a matter of minutes, because what is added is used up very quickly.

In the Cook process the operation from cold rolling to the finished, coated product is carried out in three stages. First there is annealing in batches in boxes, which by the normal processes takes some four to six days. This is followed by skin passing, in the conventional way, after which comes the coating process which involves cleaning, fluxing, drying, and passing through the bath. The claim is that the structure of the box-annealed sheet is different and essentially softer than the structure of a sheet dealt with by the Sendzimir process.

The results obtained by Dr. Bablik do not bear that claim out.

Although the Sendzimir process has an advantage in getting rid of the need for acid and flux, and the consequent fumes and other nuisances, its principal economic advantages lie in the conjunction of several operations into one. Cold-rolled strip is taken directly from a reversing or tandem mill, with no intermediate operation, and transported right to the continuous annealing and galvanizing plant.

This is the most likely direction in which future developments will move, with the possibility of a continuous casting machine for slabs, feeding a planetary mill which reduces the strip at 40-80 tons per hr. directly to a strip of about 0.80, followed by three finishing stands. This train may provide 0.5-mm. strip hot enough to go directly into a cooling chamber with just enough oxide for reduction so that it can go directly to galvanizing and finishing. Some such development can help to create a big and growing market for galvanizing products at prices which are effectively competitive.

Comparison between the Cook-Norteman and Sendzimir Processes — 3

by NELSON E. COOK

(Wheeling Steel Corporation)

THE Cook-Norteman and Sendzimir processes, both having the same goal of producing tight coated continuously galvanized material, approach the problem by entirely different methods and there are advantages and disadvantages inherent in each process.

An important advantage of the Cook-Norteman process is that non-fluting material can be furnished as a standard commercial product from the coating line. The non-fluting properties are incorporated into the basic strip material by temper passing after batch annealing. In coating this material the temperature of the strip is never raised above 850° F., and then only the surface layers of the strip are raised to that temperature. It is believed that the internal part of the strip between the two surface layers does not attain temperatures higher than 500°F. Therefore, while there is some degree of ageing of the strip while being coated, it is never so pronounced that it cannot be corrected by the cold working of one single backed-up leveller at the exit end of the line.

The most important advantage of induction heat is that the percentage of aluminium can be quickly varied almost at will. Different types of steel, such as rimmed, aluminium killed, and unannealed, and steel with different degrees of cleanliness, require different percentages of aluminium in the bath to suppress alloy layers. In using the induction furnaces, aluminium, in the form of zinc aluminium alloy, can be added directly to the inductor throats in the bath, where it will melt almost instantaneously and be mixed completely and thoroughly in the bath.

Strip surface has no apparent effect on tightness where proper controls are exercised. There is no difficulty in regulating weights of coating on smooth strip, from light coatings up to 3.0 oz. per sq. ft.

A major advantage of the Cook-Norteman process, particularly in the United States, is that a soft, workable sheet can be furnished, *directly from the line*, and within the full speed range of the line. Material in the full Rockwell ranges can be produced for the reason that the required hardness is produced in the black material and is not essentially altered in the coating process. For many types of work in the United States the customer prefers material in the 40 - 50 Rockwell ' B ' Hardness range, and this can be done easily in one standard processing.

With regard to the occasional variation in thickness of the coating layers on the two sides of the sheet it is believed that the major cause is the variation from the symmetrical arrangement of the coating rolls with respect to the moving strip. In any continuous coating process

the strip should follow a perfect vertical path from the last sink roll up through the coating rolls, and the coating rolls should be perfectly level. The exact placing of the coating rolls with relation to the sink roll is most critical, particularly at high speeds. Even the slightest positioning of the coating rolls off the pass line will result in coatings being different on the two sides of the strip. Another contributing factor is in the use of coating rolls which are not perfectly surfaced, or which are not perfectly round. When the strip is conveyed through the process under very high tension, such as in the Cook-Norteman process, there is not too much danger of the fluttering of the strip. However, a fluttering coating roll drive may, especially at high speeds, be a contributing factor.

Occurrence of Striping

Dr. Bablik has explained the cause of 'striping' on sheets which he has examined from the Cook-Norteman process. Other producers, using other processes, are now very generally producing 'striped' coatings. The stripes come from very high speeds, types of grooving, and operation of the coating rolls at slower speeds with relation to strip speeds. It does not follow that all strip made at very high coating speeds must necessarily have stripes and these stripes can be substantially eliminated at all speeds. While it is true that the striped areas have lighter coatings than average coatings on the entire strip and, from a theoretical standpoint it appears that coating is being wasted the great majority of customers in the United States prefer the striped appearance, even knowing that some areas of the coating are lighter than others, and there is very great difficulty in selling non-striped material.

It is interesting to note Dr. Bablik's discussion of the microstructure of various coatings, and his findings that in the Cook-Norteman material it seems to be characteristic that there is a dispersion of the Fe-Zn crystals in the zinc layer which is not generally present in the Sendzimir material. From this he has concluded, that the main error in determining tightness of coating by chemical determination of the total iron layer lies in the fact that it not only determines the Fe-Zn layer which is a measure of the reaction between the pure zinc and parent iron but also includes the iron present in the zinc layer in the form of Fe-Zn crystals taken up from the bath. Contrary to this theoretical consideration it has been found that the analysis of total iron in the Cook-Norteman coating is definitely a direct indication of tightness of coatings, it being almost a straight line function which is the only test needed to control the process, while research has shown that this is not true of other types of coatings. Since actual results on material from the two processes do not bear out the theory, perhaps much more work must be done to determine the basic reasons for the disagreement with theory.

Prevention of Flux Staining

It is agreed that sheets produced in a fluxing system may be slightly more susceptible to initial, multi-coloured, staining than sheets made without fluxing, if the last traces of flux have not been removed, which may be done by water washing or by washing in weak phosphoric acid solution. From a practical standpoint, however, research has shown that there is very little difference in staining of any sheets, produced by any process, unless some after-treatment is applied to retard the staining. Insofar as the fluxing problem is concerned it has been found that when the prefluxed material is introduced into the coating bath at temperatures between 350° and 500° Fahr. there is very little difficulty in minimizing flux problems as mechanical means have been devised for preventing the carrying through of the flux. An after-treatment is also incorporated which has as one of its essential components, phosphoric acid and this assures removal of any traces of flux. The samples referred to by Dr. Bablik did not have this treatment. The problem of flux carry-through causes so little concern that a new continuous line is now being engineered which will have strip speeds of at least 500 feet per minute through the process.

The first and third papers at this Session were presented on behalf of the authors who were unable to be present.

DISCUSSION

MR. H. EDWARDS (John Summers & Sons Ltd.) said that the development of the Cook-Norteman process had not been unexpected, with its potential increased production, and annealing to produce different mechanical properties.

The disadvantages of using cold-rolled strip from the point of view of high yield-point, referred to in Dr. Bablik's paper, would be removed eventually. The observation that difficult problems were involved in guiding and tensioning the strip and in centering was hardly true with present-day control devices.

Mechanical Properties of Strip

Turning to mechanical properties, the mechanical properties shown for the Cook-Norteman process were disappointing. Probably they were not representative, because Dr. Cook referred to Rockwell B hardness figures of 40 - 50 in his paper, and they might be more typical. Dr. Bablik had said that the results of tests on strip produced by the two processes "did not reveal significant differences in mechanical properties," but the Cook-Norteman sheets showed only 23 per cent. and 26 per cent. elongation in Dr. Bablik's paper and Erichsen figures of 8.3 and 10.2. It might be that those two samples were not representative, and perhaps Dr. Bablik would refer to the phenomena produced by warm tensioning over relatively small rolls followed by quenching to reduce fluting.

Mr. Edwards did not agree with the views expressed by Dr. Bablik on the subjects of surface roughness because smoother surfaces were easier to prepare and presented a smaller number of nuclei for crystallisation.

He appreciated the difficulties of running at high speeds with the bath and roll conditions very sensitive to alteration. Grooving patterns should not be troublesome with skilled practice in conditioning rolls. The addition of aluminium to spelter by the manufacturer was not mentioned in the paper, but appeared to be disadvantageous. The uniformity of the coating transversely should not present the difficulties indicated by some of the figures in the paper.

Dr. Bablik had included some notes on

atmosphere and a discussion on the possibility of renewed oxidation, and the effects of ammonia were important. The results of work in the John Summers laboratories indicated that the rate of growth of alloy was not affected very considerably or significantly by the absence or presence of a reduced iron layer on the surface, nor did the use of a slightly nitriding atmosphere for producing a reduced iron layer have a measurable effect.

Mr. Edward's last point was the composition of the bath. Low tin was a feature of present practice and did not appear to be detrimental, from work which he had done. With the addition of 0.2 per cent. aluminium, the aluminium figures in the bath usually showed 0.1 per cent., while the coatings showed 0.2 per cent. This was explained by the possibility that the zinc portion contained 0.1 per cent. and the alloy portion two to three times as much.

Mechanism of Aluminium Behaviour

Mr. D. I. CAMERON (Lysaght's Works Pty. Ltd.) said he wished to make some remarks, which linked up with the last few words of Mr. Edwards, concerning the mechanism of the behaviour of the aluminium. Unfortunately, there was no properly determined ternary diagram, so far as he was aware, covering the system Fe-Al-Zn. Some information was available, however, and general experience also provided a little additional information. It seemed that there must be an alloy containing a great deal of zinc, a little iron, and less aluminium. If this ternary alloy existed it would be expected to appear in the coating as one of the possible layers. Whereas the ordinary galvanized coating was expressed in terms of the Fe-Zn equilibrium diagram, a more complex use could be made of the Fe-Al-Zn diagram if it were established, and it would be most useful to have it.

He would suggest that a period of reduction existed before the beginning of alloy growth, but it was over in a fraction of a second for an aluminium-free coating in normal hot dipping. In their experimental work they had slowed down the initial processes of alloying by coating the steel sheet with zinc electrolytically and then heating to 400°C., just below the melting point of the zinc, when the rate of alloying permitted reasonable control of what was going on. At this temperature there was a delay of between 1 and 1½ minutes before the first alloy appeared, which was the zeta phase ; after that, other alloys appeared in sequence. In the presence of aluminium the delay was longer before the aluminium and zinc set up diffusion gradients in the iron which allowed the alloy to appear. He felt that the possibilities of ternary alloys in this system could add something to the explanation of the effects of the aluminium.

Session Vb

SURFACE TREATMENT OF GALVANIZED COATINGS

Chairman: MR. ARON

(Chambre Syndicale des Fabricants de Tôle-Galvanisée)

The Effect of Painting on the Corrosion Resistance of Galvanized Steel

P. MORISSET

(Chambre Syndicale des Fabricants de Tôle Galvanisée)

THE standard salt-spray test and the "Industrial Building" cycle were used to examine the corrosion behaviour of galvanized and galvanized and painted steel. (The latter test involves exposure to varying degrees of moisture and heat ; to SO_2 ; and to ultra-violet light).

The galvanized sheet samples taken from a wide range of commercial material carried coating weights from 200 to 900 gm. per sq. in. on both sides and the paint systems tested included zinc dust paints, bituminous paints, wash primers and paints based on vegetable oils. One- and two-coat systems were examined in some cases.

Colour photographs (many of which are reproduced in the paper) were taken at various stages of the tests and were compared with a number of standard photographs to assess the corrosion damage.

The results of tests on galvanized sheet confirmed the proportionality between coating weight and corrosion resistance. It was shown, however, that after short exposure periods, particularly in the very aggressive salt spray, there was little difference in appearance between the variously coated specimens. After longer trials, the superior quality of the thicker coatings was apparent.

For the painted specimens simultaneous attack on zinc and paint was observed in the very aggressive salt spray. In the Industrial Building Cycle the paint film deteriorated while the zinc coating remained practically unaltered.

The tests revealed the great advantages associated with using galvanized coatings compared with bare steel as a basis for paint. In the Industrial Building Cycle test, for example, 25 cycles (of 3 hours) is the normal criterion for good quality. None of the paint systems on the galvanized sheet showed even partial failure until more than 80 cycles. No rusting on any of the galvanized and painted specimens was observed until 200 cycles and about half of them showed no trace of rust after even 350 cycles.

The paints, which were of high quality, all showed good adhesion. No very wide differences in performance were noted in the corrosion tests but the vegetable-oil-based paints were the least satisfactory.

While the tests show that improved corrosion resistance is obtained by painting galvanized steel, it is stated that, in France, galvanized steel alone with a coating of 400 to 450 gm. per sq. in. gives adequate corrosion resistance. It is also emphasized that paints, when used, must be specially formulated for use with galvanized steel to obtain good results.

DISCUSSION

Mr. J. F. H. VAN EIJNSBERGEN (Stichting Doelmatig Verzinken) said that Mr. Morisset had extablished in his paper the very important fact

that hot-dipped galvanized steel was an ideal base for painting which had to be durable, and was thus the most economic way of protecting steel structures against corrosion.

When carrying out salt-spray tests the sodium chloride solution used was important, and the 20 per cent. solution as used today was not so good for testing the corrosion resistance of painted and galvanized steel.

He would also like to refer to the danger in making adhesion tests and corrosion tests on galvanized and painted surfaces which had been exposed to a certain number of cycles in a certain apparatus. In that connexion a German paper was of interest which had been presented to the second Corrosion Congress at Frankfurt on the merits and faults of corrosion salt-spray cabinets.

AUTHOR'S REPLY

Mr. Morisset, in reply, said that the 20 per cent. solution has been used because it had been standardized. It might be possible to find other concentrations or other reagents which would be more suitable.

A notable feature about the salt-spray tests was that they were extremely costly and the accelerated tests took a very long time. The industrial tests took ten months, because the paint and zinc would not deteriorate earlier. There was a great deal of work still to be done to find accelerated tests which would provide results in a month or two and give a good idea of the corrosion resistance.

Asked whether his samples had been pre-treated either chemically or mechanically, and whether he did not think that after such treatment there might be a further improvement in their behaviour, Mr. Morisset replied that no pre-treatment had been given. They had dealt with the problem in the simplest possible terms. They had taken galvanized sheet and put the paint on it in the laboratory immediately. Pre-treatment would have given a still further improvement, but that was not the problem with which they had been concerned.

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Session VI

EFFECT OF GALVANIZING ON PROPERTIES OF STEEL WIRE

Chairman: Mr. A. JØRGENSON

(Nordiske Kabel-og-Traadfabriker)

Variations in the Characteristics of Steel Wire as a Result of Hot-Dip Galvanizing — 1

B. ULRICH

(Nederlandsche Kabelfabriek)

THE influence of galvanizing on the mechanical properties of wire is most marked for patented wire ; the properties can be restored, however, by drawing after galvanizing, although this requires a relatively heavy initial coating on the wire if the final product is to be adequately coated.

The galvanizing process involves short heat treatments in a lead bath at about 400°C. and in a zinc bath at about 450°C. This results in a reduction in tensile strength (if the wire has previously been drawn from 50 per cent. or more), an increase in the 0.01 per cent. yield strength (since there is no true elastic limit in drawn wire) and an increase in elongation ; furthermore, the reduction of area at rupture is decreased, the number of bends and twists the wire will sustain is reduced and the fatigue properties are adversely affected.

These changes are caused by the roughening of the surface in pickling and in galvanizing, and by the tempering effect of the lead and zinc baths. Roughening of the wire surface increases the notch sensitivity and reduces the admissible alternating stress, while tempering causes the deterioration in tensile strength and the increase in elongation.

The dominant zinc-iron alloy layer formed in galvanizing is hard and brittle, and will crack when the wire is twisted or bent ; these cracks may be propagated into the steel itself. Removal of the coating to some extent restores the torsion and bend properties of the wire.

If the wire is to have its properties restores by final drawing, the alloy layers should not be thick ; if the wire is galvanized at its final diameter, it should be hard drawn after patenting, and bath temperatures should be kept as low as possible.

Variations in the Properties of Steel Wire as a Result of Hot-Dip Galvanizing — 2

by F. BALDI, G. GARBELLI and A. PIROZZI

(Acciaierie & Ferriere Lombarde Falck)

THE results of mechanical tests on steel wires of different carbon content after varying amounts of cold reduction, were examined on a statistical basis and the results are summarized below.

Tensile strength is reduced as a result of galvanizing but to a limited degree. The variation in the ultimate tensile strength tends to increase with increasing cold reduction and with increasing carbon content. The effective lowering of properties is more accurately represented however by changes in the breaking load which incorporate effects due to galvanizing and the thickness of the zinc.

The percentage elongation increases considerably as a result of galvanizing. The percentage elongation depends on the percentage reduction in drawing ; in particular for carbon contents exceeding 0.55 per cent. the relation between the percentage variation in elongation and percentage reduction may be represented by a linear equation. The percentage variation of elongation also increases as the carbon content is decreased.

The number of torsions is reduced considerably as a result of galvanizing. The percentage variation decreases with increasing cold reduction and may be satisfactorily represented by a linear function. The results of the tests however do not show a clear relationship between the reduction in torsion properties and carbon content.

The number of bends is reduced considerably as a result of galvanizing though on average less than the number of torsions.

The percentage variation of the number of bends also decreases as a result of increasing cold reduction. This result however was found to be true only with the steel with higher carbon content, in the tests on wires of the same diameter obtained by varying degrees of drawing down.

Chemical stripping of the wires to a large extent

restores the original characteristics of torsion and bending, while strength and elongation characteristics remain practically unchanged in comparison with the galvanized wires.

Variations in the Characteristics of Steel Wire as a Result of Hot-Dip Galvanizing — 3

by R. DEBIE

(Tréfileries Leon Bekaert)

COMPARING the two previous papers on this subject it is found that Ulrich has reported a marked decrease in tensile strength for reductions of 80 per cent. or over, with no appreciable affect on wire reduced by less than 80 per cent. Baldi and his co-workers on the other hand, have found that the tensile strength is reduced to a limited degree, the percentage variation tended to increase with increasing cold reduction and with increasing carbon content.

Whereas Ulrich has found that the elongation increases considerably, independently of the reduction of area, the Italian authors have said that it increases considerably depending on the percentage reduction in drawing.

While resistance to torsion and bending failure are said by Ulrich to decrease by 30 to 40 per cent., Baldi has reported a considerable reduction, the percentage variation decreasing with increasing cold reduction.

The comparison indicates some differences in the results which must be attributed to some uncontrolled variables in the galvanizing process. However, both papers have reached the same general conclusion that the attack of the molten zinc on the surface of the drawn wire, with the formation of a brittle zinc-iron alloy layer is largely responsible for the drop in resistance to torsion and bending, and that the tempering affect of the lead and zinc baths decreases the tensile strength and increases the elongation.

It is interesting to consider whether, in the light of the foregoing, a restriction in the formation of the zinc-iron alloy layer would lead to a reduced loss in resistance to torsion and bending. If such is the case, the addition of aluminium to the galvanizing bath should have a significant effect on such loss.

Also it would be of interest to study the influence of a short period of heat treatment at 450°C., without galvanizing, as there seems to be some evidence that it is the heat treatment alone which is largely responsible, not only for the decrease in tensile strength and the increase in elongation, but also to a large extent for the drop in resistance to torsion and bending.

It is very desirable to know whether the most significant losses in mechanical properties during galvanizing are due to the heat treatment at 450°C. or not. If it is so it would appear to be a problem for the steelmaker, whereas if not, and it is a function of the zinc coating, it is up to the galvanizer to see what can be done.

Variations in the Properties of Steel Wire as a Result of Hot-Dip Galvanizing — 4

by G. MILLER and J. E. WOULD

(Spencer Wire Co. Ltd.) (Dorman Long & Co. Ltd.)

IT is generally accepted by steel wire users and reflected in modified specifications relating to drawn and-hot dip galvanized wire, that some deterioration of certain physical properties occurs, particularly as shown by torsion and reverse bend tests after galvanizing.

The preceding papers bring attention to average variations from as-drawn figures for particular processing conditions. A basic problem of high-tensile steel wire makers, however, is the increased range of variations in the actual values obtained from individual tests on the fully galvanized product. Variations in the pre-galvanized state must therefore be taken into consideration in assessing the effect of galvanizing.

To quote an example on 0.082-in. diameter 115/125-tons per square inch hot galvanized wire manufactured from acid steel, the following figures are represented by a 5-ton batch :—

Bright Wire drawn from 0.192-in. diameter 0.75/0.80 per cent. carbon.
Lead Patented Wire Furnace Temperature 950°C.
Lead Bath Temperature 500°C.
Size 0.080 in. diameter
Tensile 124/130 tons per sq. in.
Torsions 32/37 in 100 diameters.
Bends 9/11 on 5 m/m R.
Elongation 2.00/2.25 per cent. in 10 in.
After hot galvanizing :
0.082 in. diameter.
Tensile 117/124 tons per sq. in.
Torsions 10/29 in 100 diameters.
Bends 6/13 on 7.5 m/m R.
Elongation 4.25/4.50 per cent. in 10 in.

The final tests resulted in rejections as follows :
9 per cent. of the batch rejected on low torsions, and,
4½ per cent. of the batch rejected on low bends.

Additional to the above was the rejection of 3 coils, approx. 3 per cent. for irregular torsions, although the specified minimum was obtained on the test pieces. In total, a rejection of 16½ per cent. resulted, which is not uncommon for this grade of wire.

Control of Variables

There is some evidence to suggest that in general, both overall and individual variations are considerably influenced by factors capable of some control, such as time of immersion and zinc temperature and that degree of uniformity of alloy layers and of internal stress release are probably also important.

Nevertheless, from the typical example given above, it would seem that there is a great need for the wire trade to perfect the technique of hot galvanizing to provide heavy castings in the patented condition and subsequently draw to the finished size.

By this method uniformity and physical tests are approaching the standards laid down for bright wire providing the galvanizing has been carried out so as to provide an even pick-up of zinc along the length of the wire.

The recovery of the peculiar plastic characteristics of drawn wire conferring improved resistance to shock loading in particular, the the resultant consolidation of the coating are also important advantages resulting from final drawing.

Need for Even Coating

However, the one real problem encountered on drawn galvanized wire is to provide the heavy even coating which allows drawing without excessive zinc loss:

Vibration and " shipping " of the wire on the galvanizing plant is probably the major factor which produces an uneven coating of zinc on the wire emerging from the zinc bath and a good deal of engineering skill and ingenuity is called for in an effort to overcome this trouble, especially at the higher rates of withdrawal required for the greatest pick-up of zinc.

This uneven coating of zinc on the wire does not level out in wire drawing as is sometimes thought. The proof of this statement can be confirmed by the simple method of stripping the zinc after drawing a lengthof unevenly zinc coated wire, when it will be found that the steel wire is irregular in size and cross section.

In severe cases on smaller sizes of wire this irregularity

in size and cross section can have an adverse effect on the physical properties.

From extensive experiments carried out, the following points seem worthy of further consideration when the extra thick zinc coating on patented wire is a requirement.

Taking as an example 8-s.w.g., 8.160-in. diameter wire, galvanized at various speeds. The results summarized are given below :—

60 ft. per minute. (Fast speed.)

At this speed heavy drag out of zinc can be attained, but it was found that excessive " whipping " and vibration caused a very irregular coating and in small sections of the wire after drawing the copper sulphate dip test showed up the deficiency.

3 ft. per minute. (Slow speed).

Here again a heavy drag out of zinc was possible and with much more uniformity due to the reduction of vibration and whipping of the wire which was attained at the very slow speed but the main trouble on this method was the heavy alloy layer which the long immersion in the bath produced. After drawing, this alloy layer became very brittle and cracked on the wrapping test.

20 ft. per minute.

This speed seemed to give the most uniform coating of zinc on the wire, but the drag out was less than at the other two speeds. However, uniformity of coating could be controlled with the aid of a light charcoal wipe and the alloy layer formed on the wire was fairly normal. With great care and attention in both galvanizing and wire drawing processes, satisfactory wire could be produced at 75 to 80 per cent. reduction of area to meet standard specifications.

On the other hand, in order to produce the heaviest coatings in the highest tensile ranges comparable with those obtained by finally galvanizing, there is no doubt that a great amount of technical and practical work is required to perfect this method to ensure adequate and uniform zinc coating. Many British wire manufacturers at the present time are studying this problem with varying degrees of success.

DISCUSSION

MR. HILLESHEIM said that Mr. Ulrich's paper clearly showed that much more work was needed in order to produce galvanized patented wire with suitable mechanical properties. He suggested that a maximun of 40 per cent. reduction after galvanizing was to be preferred for restoration of properties.

In his view, the lead bath was neither the usual nor the best method of grease removal. In assessing the change in tensile properties, it was more appropriate to consider the total load which could then be related to core diameter or total diameter, thus taking into account the thickness of the zinc. In bend tests also the difference in diameter before and after galvanizing would have an effect. There was an additional effect on bending properties due to actual bending of the wire during processing. Wire sent through the machines without actual pickling or galvanizing had shown a slight drop in bend properties. Thus the drop reported due to galvanizing was too high. He considered that the reported 30 to 40 per cent. lowering in torsion properties was also too high. In favourable circumstances it might be as low as 10 to 15 per cent. and in well-run plant where galvanizing was the final operation, it should not be more than about 25 per cent. The results of fatigue tests reported in the paper did not agree with practical results on wire cables. Recent work by Pungel had shown that even in the absence of corrosion, long-term bend fatigue results for galvanized and bright steel wire were similar. Galvanized wire was superior when corrosion was involved. For 2,000,000 reversals the maximum stress for bright wire was 40.5 kg. per sq. mm. in dry conditions and 20.5 and 19 kg. per sq. mm. in sea water and distilled water respectively. The comparable figures for wire drawn 40 per cent. after galvanizing were 36.2 kg. per sq. mm. in dry conditions and 35, 34 and 32.8 kg. per sq. mm. in mains water, sea water and distilled water respectively.

In a survey carried out by the Cable Testing Station of the German Mining Association covering the years 1936/1957, galvanized cables in a wet mine shaft in Dortmund were found to have an appreciably longer life than bright steel cables. Even in dry shafts, the average life of bright wire was found to be 750 calendar days compared with 810 calendar days for galvanized cables. In wet shafts the times were 630 and 820 days for bright and galvanized wire respectively.

In a statistical survey (1936-1956) of cables in subsidiary shafts, the average life of bright steel cables was 1280 days compared with 1400 days for galvanized cables and in wet shafts the figures were 1020 and 1450 days for bright and galvanized cables respectively.

In conclusion, Mr. Hillesheim said that it was important to control the effect of galvanizing on mechanical properties since large quantities of patented galvanized wire were being produced in which galvanizing was the last operation. Currently, 10,000 tons of patented wire were being galvanized which was 30 - 50 per cent. of the total output of patented wire.

* * *

Session VIIa

EFFECT OF ADDITIONS AND IMPURITIES ON THE GALVANIZING BATH

Chairman: DR. R. HAARMANN

(Siegener A. G.)

The Influence of Aluminium, Lead and Iron on the Structure and Properties of Galvanized Coatings

J. J. SEBISTY and J. O. EDWARDS

(Canadian Dept. of Mines and Technical Surveys)

AS a first step in a more extensive study, the influence of aluminium and lead on the structure and properties of laboratory-prepared galvanized coatings was

investigated over a range of bath temperatures and immersion times. Baths were saturated with iron, and steel sheet with two different degrees of surface roughness was used.

On the basis of a statistical evaluation of the data obtained in this preliminary series of tests, some general relationships were revealed with respect to the relative influence of the experimental variables. These and other observations are summarized below :

For the experimental conditions studied, immersion time and aluminium content of the bath had the most significant effect on such factors as coating weight, iron content in the coating, steel weight loss, iron-zinc alloy thickness, proportion of alloy in the coating, and ductility and adherence of the coating. The bath temperature was also significant but, in general, to a lesser degree than the immersion time and aluminium content of the bath. Variation in steel surface roughness and the lead content of the bath had no significant effect on the factors listed above.

With respect to surface appearance characteristics such as roughness, brightness and spangling behaviour, the only galvanizing variable which exerted a consistent significant effect was the lead content of the bath. The bath temperature steel surface roughness and aluminium content showed varying orders of importance.

The addition of 0.2 per cent. aluminium to iron-saturated baths was effective in largely blanking-off attack of the steel base for immersion times up to 2 minutes.

On the other hand, 0.1 per cent. aluminium promoted vigorous steel attack and continuous alloy growth even at short immersion times. For short immersion times only, the degree of attack was less severe than when aluminium was absent, but with increasing dipping time this beneficial effect disappeared and 0.1 per cent. aluminium in the bath promoted a more rapid rate of attack than occurred with no aluminium present.

Although the results were somewhat erratic, differences in corrosion behaviour as determined by accelerated corrosion tests suggested that aluminium had a significant effect in promoting " white rusting ", and this applied to a lesser degree to the lead content of the bath.

For the practical galvanizer, the following additional points may be inferred from this preliminary investigation.

Lead additions to the baths appear to have no effect on such properties of the galvanized coat as adhesion and ductility, but do affect its appearance.

In sheet galvanizing, where the coating thickness can to some extent be controlled by manipulation of the exit rills and withdrawal speed, the results suggest that short immersion times and high aluminium content will produce better quality sheet. There are indications, however, that aluminium increases the tendency to white rust formation.

The fact that virtually all of the iron dissolved from the experimental specimens was accounted for by the iron in the coatings suggests that under properly controlled conditions it should be possible to maintain a low level of dross formation in dry galvanizing.

Session VIIb

EFFECT OF STEEL COMPOSITION ON THE GALVANIZED COATING

A Study of Surface Carbides, Differential Steel Attack and Pore Formation in the Galvanizing Process

J. J. SEBISTY
(Canadian Dept. of Mines and Technical Surveys)

AS an offshot of a more-detailed investigation, the effects of massive surface carbides on the structure of the galvanized coating and the phenomena of differential steel attack and pore formation on the galvanized surface were examined with the following results.

In all cases where massive carbides were present on the surface of the steel sheet, there was no gamma or delta in the alloy overlying the carbide. In iron-saturated baths with nil or high aluminium the carbides were relatively unreactive and in some cases with high aluminium the carbides were not even wetted, giving rise to bare spots in the coat.

At intermediate aluminium contents (0.1 per cent.) and at temperatures above 450°C. (824°F.) in iron saturated baths, the carbides reacted vigorously with the zinc to give massive zeta crystals in the coating, and a transformation product on the surface of the carbide. At lower temperatures (435°C. (815°F.)) the carbides were again relatively unreactive.

The difference in coating weights obtained under identical galvanizing conditions, on two supposedly similar sheets, was related to excessive rolling and smearing of the high spots on the surface of the more reactive steel sheet.

Examination of the pore defects on the surface of experimental and commercial flux galvanized material showed that the pores were shallow depressions associated with small particles of zeta phase. It is suggested that these pores were formed by gas evolution due to flux reaction, either within the bath or on the surface of the steel during the galvanizing operation.

The Influence of Steel Quality on the Thickness of the Zinc layer in Hot-Dip Galvanizing

W. GERBER, R. GLOOR and H. OERTLI
(von Roll'sche Eisenwerke)
(Verzinkereiwerke A. G. Kummler und Matter)
(Bernische Kraftwerke A.G.)

FOR effective under-water protection, galvanized coatings must be heavier than those obtained in normal practice. It is known that increases in coating thickness can be obtained by the use of longer immersion times ; a series of tests was carried out to determine whether steel composition has any effect on the zinc coating produced in galvanizing.

In the first test two steels of different silicon content were used, and it was found that the coating thickness for the higher silicon steel was the greater of the two, for each immersion time.

The second test was performed on fork-shaped samples, each of five prongs being made from a different melt of steel ; the silicon contents of the steels varied from 0.05 per cent. to 0.73 per cent. Coating thickness was found to increase with silicon content and also with immersion time, the latter being particularly important with the steels of higher silicon content.

In fabricated articles it is important to have a similar coating thickness on the weld seam as on the rest of the article. In the case of one steel, the proper choice of welding electrode resulted in galvanized coatings on the seam, comparable with those on the basis material for all immersion times examined.

A coating thickness of 0.3 mm. will provide good under-water corrosion protection ; such a coating was produced on steel of 0.38 per cent. Si with an immersion time of 8 min. at a temperature of 450°C., and this grade of steel has since been galvanized and used in practical application in Switzerland ; it would be suitable for severely corrosive atmospheric conditions in other countries.

DISCUSSION

MR. E. C. MANTLE (British Non-Ferrous Metals Research Association) said that the work on the influence of aluminium, lead and iron on the structure and properties of galvanized coatings, reported by Sebisty and Edwards, to a large extent duplicated research work already carried out in the British Non-Ferrous Metals Research Association by Haughton and reported on to the Dusseldorf Conference, and work on the effect of lead on the properties of coatings recently published by the Association in *Sheet Metal Industries*. It was pleasant, to find that the authors had largely confirmed the conclusions of the B.N.F.M.R.A. workers both with regard to the effect of aluminium on the zinc/steel reaction and also with regard to the effect of the presence of lead in galvanizing baths.

The Association had examined the effect of lead recently both from the point of view of general galvanizing practice and also with continuous galvanizing strip and wire in mind. They had worked with baths free from aluminium, with an addition of 0.05 per cent. aluminium and with an addition of 0.15 per cent. aluminium, in each case duplicating the work with baths free from lead and baths containing about 1 per cent. of lead. They had found, just as Sebisty and Edwards had found, that the presence of the lead had no effect on the structure of the coating, on the coating weight or on the ductility of the coating. In those respects the addition of lead had been completely harmless. The preliminary results obtained by the Association also suggested that it had no effect on corrosion resistance either. They had, however, found that lead considerably facilitated the production of smooth galvanized coatings, and this comment was also made by Sebisty and Edwards. There seemed, therefore to be practical advantages in having lead in the galvanizing bath, and, since it did not appear to harm the properties of the coating, there was no reason why lead-free zinc should be specified for certain applications such as galvanized core wires for aluminium cables, as in the United States.

There were a few minor points in the paper on which he wished to comment. He thought that the dipping times were not really representative of continuous galvanizing practice. The authors' minimum immersion time was 25 sec., which was much longer than in strip or wire galvanizing. In the Association's work a minimum dipping time of 10 sec. had been used, which represented continuous galvanizing, with longer times to represent general galvanizing. The authors' method of stripping to determine the coating weight and the amount of iron in the coating was also, he felt, a little suspect where work on the effect of aluminium additions was concerned. In the Association's work it had been found that where there was a thin alloy layer produced in the baths containing about 0.15 per cent. aluminium, this very thin alloy layer was not dissolved by the stripping acid, and there was a tendency, therefore, for the weight loss to appear lower than it actually was and for a corresponding error to be made in determining the amount of iron in the coating.

Mr. E. C. Mantle makes a point in discussion

He thought it was surprising that the authors found no statistical correlation between the roughness of the steel and the coating weight, although they did comment that in many cases they found that the outer zinc layer tended to be thicker on one side than the other. That had been noticed in the Association's work, and they had attributed this difference in coating weight on the two sides of the same sheet to differences in surface roughness between the two sides of the steel. They found that the surface roughness of the steel in galvanizing strip and in galvanizing wire had an important influence on coating weight, and more particularly on the ductility of the coating.

In connexion with ductility, the tests which the authors had used seemed to be much too severe for most of the coatings studied. With normal coatings of reasonable thickness one expected corrosion resistance rather than ability to withstand close bends, and it was only the relatively thin coatings typical of continuous galvanizing which could be expected to withstand the severe deformation which the authors had used in some of their tests. He was also doubtful about the validity of the acceleration of corrosion tests, and thought it

was unwise for firm conclusions from these accelerated tests to be drawn ; it was better to wait for the atmospheric exposure tests to be completed.

In the complementary paper by Sebisty on surface carbides, a most interesting explanation was put forward, that the development of massive zeta crystals was connected with the presence of carbide at the surface of the steel. This certainly seemed to be a subject which was worthy of further study. In the Association's work they had noticed the same sort of thing, but had not been able to tie it down to the presence of carbide. It seemed to occur particularly on the sheared edge of the sheet, where the surface was relatively severely cold worked.

MR. V. HARDY (S.A. Phenix Works) took the opportunity to mention that they had developed in 1951 a rapid spectrophotometric method for the simultaneous determination of iron and aluminium in galvanizing baths, a description of which had been published in the French review *Metaux — Corrosion et Industrie* for December 1952. Since that time it had always been in current use at the Phenix works, and had been and was of great service to them in the starting up and daily control of their Sendzimir plant. It had the merit of not involving the need for a costly spectrographic installation.

The principle of it was to make use of the colour developed by Alizarine S in a medium buffered with the ions Al^{+++} and Fe^{+++}. The procedure was that the zinc was dissolved in 50 per cent. hydrochloric acid. The solution was treated with hydrogen peroxide, and an aliquot part of this solution was rendered slightly alkali with ammonia. This was transferred to a buffered acetic medium, the colour added, brought up to volume and the extinction measured on a wavelength of 525 millimicrons (for iron) and 600 millimicrons (for aluminium). The spectrophotometer used was a Beckman prismatic model B. The time taken for an isolated sample was 25 to 30 minutes, but the time was reduced when a series of determinations were made. The influence of *p*H, the accuracy, the reproducibility and the influence of contaminants had been studied.

DR. D. HORSTMANN (Max-Planck-Institute für Eisenforschung) said that with short immersion times for a bath of fixed aluminium content the effect of aluminium was to restrict attack on the iron. The extent of attack, measured as the iron loss, increased with increasing immersion time slowly at first then at a much higher rate and finally there was a slight falling off. Increasing the aluminium content increased the time at which the iron loss became noticeable, but increases in temperature acted in the opposite way. The essential point was that it was necessary to have a certain minimum aluminium content in the bath in order to obtain an inhibiting effect.

Session VIIc

NON-DESTRUCTIVE TESTING OF GALVANIZED COATINGS

by W. PEPPLER

(Gutehoffnungshütte)

THE nature of a galvanized coating is determined by its thickness and structure which are affected by all the factors involved in the galvanizing process and which determine the field of application of the galvanized article.

The structure of the galvanized coating can be influenced only to a very limited extent independently of the coating thickness. Coating thickness alone therefore — which can be determined by non-destructive methods — will also give an indication of the structure of the coating.

The conception of coating thickness is closely examined, and it is shown that the metallographically recognisable coating thickness and that determined by electro-chemical of magnetic methods differ only slightly from the total coating thickness (beginning at the 0 per cent. Zn level) and for all practical purposes represent the actual coating thickness.

The various methods of measuring coating thickness, destructive, partially destructive or non-destructive, are examined and particular attention is paid to local electrochemical removal of the coating and to magnetic gauges.

Gauges known and used in Germany for magnetic measurement of coating thickness in the range 0 to 0.3 mm' are described, and an assessment of their reliability in measuring the thickness of homogeneous non-magnetic foils under various conditions is given.

The calibration curves of all the gauges are very similar and, with the exception of the simple magnetic gauge at the lower range, show a linear relationship between the indicated and real foil thickness. Factors which influence the magnetic permeability (such as carbon content) as well as the shape and size of the test piece are shown to influence the accuracy of measurement. These effects can, however, be nullified if the gauge is adjusted on a test piece of the same shape and size and nature as the material to be examined. However, with section thicknesses of at least 6 mm. and level surfaces of at least 100 x 100 mm. with the gauge placed centrally, the effects due to area and section thickness are negligible. With two-pole gauges, the magnetic mean value for non-uniform coatings is lower than the arithmetic mean of the coating thicknesses under the individual poles when these are markedly different.

In general, it has been shown that magnetic methods of measuring homogeneous nonmagnetic foils are accurate providing that certain simple precautions are observed. The author expects that the magnetic gauges will be satisfactory for all practical purposes for the measurement of the thickness of non-homogeneous hot dip galvanized coatings.

DISCUSSION

MR. W. R. THOMPSON (Painter Bros. Ltd.) said that he had found that it was almost impossible to obtain accurate readings with magnetic gauges unless the instrument was zeroed at a certain point on the base material after pickling and then applied to exactly the same point after galvanizing. That, of course, was all right in the laboratory, but it was

not always practicable in the shop. In any case the instrument only recorded the thickness of the coating at the actual point of contact. He felt that magnetic gauges should be regarded only as something to be used in conjunction with some other form of measuring, such as weighing before and after. It might be, of course, that he had been unfortunate in his choice of instrument, and he would be interested to hear the views of other delegates on this point.

Back-Scatter Gauge

Turning to other types of gauge, he would like to bring to the notice of the Conference a completely new type of non-destructive gauge which had been developed in the United Kingdom. It was known as the beta-ray back-scatter gauge, and consisted of three parts, a mains stabilizer, an indicator unit, and a measuring head, mounted on a wheeled trolley so that it was portable within the range of the nearest electrical supply point. The instrument worked on the principle that the amount of beta radiation which was back-scattered from a galvanized surface depended on the density of the coating and was intermediate in value between the back scatter from steel and that from pure zinc.

The measuring head, which was cylindrical, approximately 3 in. in diameter by 9 in. long, had a small radioactive source of strontium-90 located at one end, and when placed on the sample examined an area of $1\frac{1}{2}$ sq. in. To make the measurement, the gauge was set by placing the head first on a steel plate and then on a plate of pure zinc. The head was then transferred to the samples to be measured, and the thickness of the coating obtained directly from the meter reading, the indicator being calibrated in oz. per sq. ft. and reading from 0 to 4.5. It had been established that the gauge was accurate to within $\pm$ 5 per cent. and could be used on any galvanized coating up to a temperature of 350°C.

Adhesion

Dr. J. W. Boon (Metal Research Institute T.N.O.) said that the adhesion of the zinc layer to the steel base should be mentioned. In most cases this adhesion was perfect, but there were cases of bad adhesion. An investigation of the adhesion was desirable in many cases, but only destructive testing methods were known.

As far as thickness testing was concerned, in the Netherlands their experience of magnetic testers had not been particularly encouraging and therefore an electro-magnetic tester was chiefly used, and in particular the T.N.O. electro-magnetic thickness tester. It was built on normal principles and had a head with a steel point and a coil through which current was passed.

The results showed that the nature of the steel base had no, or at the the most a very slight, influence. The tester could be used only on flat or nearly flat parts of the galvanized objects, but, when used in those circumstances, no influence of the form or dimensions of the galvanized objects on the results of the measurements could be shown. That applied to all parts of the object, including protruding parts and so on. Also, the thickness of the steel base had no influence on the results, but the results were influenced by the surface roughness on the steel base on which the zinc layer was applied.

They measured with the tester the thickness of galvanized layers and of sprayed zinc layers, but a different scale for recording the results was employed. The reproducibility of the results was very good. Numerous experiments and comparisons with the results obtained by stripping or by microscopic methods had led them to the conclusion that the thickness of the galvanized layer and steel base could be determined within an error of $\pm$ 3 per cent. The good results obtained with the electro-magnetic tester were in their opinion connected with the fact that these testers used a much smaller magnet than those based on a permanent magnet, with which the magnetization of the steel base and the remanence of this magnetization had much more influence on the result.

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Session VIII

HUMAN PROGRESS THROUGH TECHNICAL PROGRESS

Chairman: Mr. Le Page

(Phenix Works S.A.)

The Contribution of Galvanizing to Human Progress

R. Lewis Stubbs

(Zinc Development Association)

THE difficult art of zinc smelting was not introduced into Europe until the middle of the eighteenth century. At about the same time the French chemist Melouin suggested applying a zinc coating to iron objects by dipping them in the molten metal, but it was not until Sorel introduced a practical method of cleaning a hundred years later that galvanizing became a commercial process. The progress of the Industrial Revolution gave impetus to the new industry and galvanizing was much in evidence at the first Universal Exhibition in 1851. Corrugated iron, a new product, found a big market in the new countries where the settlers soon appreciated its convenience, and galvanized wire was becoming widely used for fencing. A British firm installed special plant to galvanize the wire for the first Atlantic telegraph cable. In the 1870s the inventions of Bessemer and Siemens made steel widely available and increased the field for galvanizing, while the new interest in hygiene created a demand for galvanized tube.

Since 1900 the expansion of the industry has been

even more rapid, and galvanizing is now used for a wide variety of steel structures, including mine cars, bridges, television towers, ships' deck fittings and livestock feeding troughs. The future expansion of the industry depends upon an even wider acceptance of the economic value of long-term protection, on greater productivity and lower costs and on the provision of coatings with even better corrosion resistance.

Human Progress Through Technical Progress

J. DERRIDER
(Travail Méchanique de la Tôle)

FOR a long time the technical progress of galvanizing was slow and less spectacular than what was seen in many other industries, although research work into many of its problems had not been lacking. This can be attributed to the fact that for a long time there were not sufficiently large markets for galvanized products to allow for more speedy and extensive development.

However, over the past twenty years, and particularly during the last decade, the field for the practical application of galvanized articles has been considerably widened, and in view of this increased demand the industry has been effectively developed with the aid of new knowledge supplied by many branches of science. Advances in the techniques of production have brought about both improvements in quality and reduction in cost and manufacture.

Galvanizing is now considered the most effective method of combatting corrosion, and while there are few new products being galvanized, the improvements in quality and cost coupled with an intensive sales campaign, have gone far to convince a wide range of industries of the importance and value of protecting their structures against rust.

Hot-Dip Galvanizing in the Netherlands

J. F. H. VAN EIJNSBERGEN
(Stichting Doelmatig Verzinkerij)

SINCE the introduction of the hot-dip galvanizing process in the Netherlands in 1876 it has rapidly gained importance as a finishing technique. Galvanizing was extensively used during the twenties and thirties, for railway electrification in Holland, as well as for transmission towers. After 25-35 years exposure to marine and industrial atmospheres, their excellent service behaviour has lead to many other major applications, *e.g.* ships, mine cars, locks, pipes and agricultural equipment.

The rapid industrialization in Holland after the second world war has called for an additional substantial tonnage of zinc for this process.

Hot-dip galvanizing has made it possible to keep maintenance costs low, which increases in the costs of steel and labour have made of more importance than ever before. Galvanizing can show a 50 per cent saving per annum over a conventional four-coat paint system.

Hot-dip galvanizing has proved to be the only effective way of protecting steel structures from stress corrosion cracking in plants producing nitrates.

The increased aggressiveness of the atmosphere due to pollution by industrial gaseous effluent can cause accelerated corrosion of zinc coatings. This can be countered by painting the zinc surface with properly selected chemical resistant coatings which results in considerably longer life for the zinc coating and an increase in the durability of the paint system of 40-65 per cent.

DISCUSSION

MR. A. VAN HAAGEN (N. V. Plaatwerkerij en Verzinkerij v/H. P. Bammens & Zoon) said that after all the technical sessions the Conference was back again on the theme of human progress through technical progress. He had the impression that they were better able to deal with technical progress than with human progress. He said this not only because there had been so many excellent technical papers at the Conference but also because the speakers in sessions 1 and 8 had talked about technical and scientific progress giving better working conditions and better living conditions, which was not the same thing as human progress. He must confess that he would have taken the same view if he had had to write a paper on the subject; he would have talked about better working conditions in the galvanizing industry, and in fact a great deal had been done in that direction in the Netherlands since they started galvanizing in 1876. Those better conditions had been achieved through technical progress.

Mr. D. M. Andrew (Water Heating Systems Ltd.) (left) in informal discussion with Mr. L. A. J. Lodder and Mr. C. R. Lyons (Consolidated Zinc Corporation (Sales) Ltd.)

If he had done that, however, he would not have been content, and he felt that neither of the authors had really been content ; everyone felt that there was something missing. The difficulty was, of course, that, as Mr. Busch-Jensen had said in the first session, they all knew what technical progress was but they had no clear definition of what human progress was. Mr. Stubbs had put the position very simply by saying that for the majority of people technical progress was synonymous with human progress ; but in that case Mr. van Haagen could certainly not agree with the majority, and Dr. Bablik in his opening speech had clearly pointed out the great dangers for humanity which existed simply owing to this technical progress. Human progress in Western Europe seemed to be concerned with eliminating fear — fear of hunger, fear of epidemics, fear of war. This was one of the objects of the United Nations.

In this world, with its rapidly growing population, this could be achieved only with the aid of tech-

nical progress, but at the same time this technical progress was able to destroy humanity. Technical progress was simply an instrument which could be used rightly or wrongly. Although technical progress and human progress were advancing side by side, they were not necessarily doing so at the same rate. In fact a dangerous discrepancy existed between the two. Morally and spiritually we were not making progress but still thinking in the terms of a hundred years ago.

In this picture the contribution of hot-dip galvanizing did not seem to be critical or dangerous. When technical progress was used for human progress, that industry could certainly make a valuable, though perhaps a modest, contribution.

MR. C. ORIGONI (Origoni & Co., Metalli) referred to what had been done in Italy by the galvanizing industry to improve the conditions of human life. In addition to making galvanized goods, as in most other countries, which had led to some improvement in living conditions and housing, he believed that Italy had been one of the first countries to transmit electrical energy over many hundreds of miles by wires suspended from galvanized steel towers. If it was claimed by some people that these transmission lines spoilt the beauty of the countryside, they at any rate provided a means to bring electric power and electric light not only to the towns but to the small villages, and enabled Italian companies to compete for the sale of electric lamps in foreign countries, including Australia, India and South America. It had also been possible to prevent damage by frost to fruit trees in winter, which was especially important in the Alpine valleys, and to irrigate the fields in areas where there was plenty of sunshine but rain was scarce, by plants which pumped water from underground and distributed it as artificial rain, thus increasing the production of fruit, cereals and vegetables and improving the living conditions of the people. Galvanizing had a part to play there also.

Just as the physicians, by combatting disease, tried to give human beings a longer life, so galvanizers by preventing rust could give longer life to steel.

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Session IX

MATERIALS HANDLING

Chairman: MR. C. ORIGONI

(Origoni and Co., Matelli)

Materials Handling in Galvanizing

A. G. NORTHCOTT

(Zinc Development Association)

MATERIALS handling is vital to human progress but, although important advances have been made in the past, its proper development has been retarded by the availability of cheap labour.

Its importance to the galvanizing industry is revealed by costing and more particularly by detailed studies which show that handling absorbs most of the labour costs. Methods of improving efficiency are set out in detail, and again emphasize the importance of handling to the industry.

A section deals with some of the causes of bad handling and shows how charting methods reveal possible improvements. The practice of dealing with handling problems piecemeal is condemned and the use of unsuitable handling equipment is shown to lead to inefficiency.

In discussing the influence of plant layout on materials handling, a number of questions are tabulated, consideration of which should lead to improvements. Three flow diagrams show the existing layout of the two galvanizing works of one company and the improvement to be obtained from the closing of one works and the reorganization of the other to give a much greater throughput. The integration of equipment and handling with layout are clearly shown. The main section deals with recommended practice for materials handling and shows how a systematic study of existing activities should be combined with consideration of a number of handling principles which have evolved from many years of practice. The principles can be summarized : eliminate unnecessary handling ; introduce programming ; integrate handling with processing ; achieve maximum progression and continuity ; move in racks, containers or pallets ; combine operations wherever possible ; use gravity where possible ; avoid contact with the floor ; classify materials and products ; and mechanize wherever possible.

Many photographs illustrate bad handling and many suggestions are made for improving handling in the industry.

The paper concludes by suggesting that productivity can be doubled and in some cases increased many times by a greater concentration on materials handling. The attitude of managers and supervisors will determine results.

Practical Approach to Materials Handling

CH. VAN KEMPEN

(Johan Vis and Co., N. V.)

IN galvanizing the question of transport is not just one important factor, it is the only important factor, because galvanizing is not a shape changing procedure but simply a movement of articles to give them different treatments.

It is commonly considered that the galvanizing process consists only of pickling and galvanizing, but if all the possibilities are realistically considered about 15 possible treatments are involved, although not more than 10 of them are usually needed in respect of a given article.

The usefulness of a certain method of galvanizing cannot be established by studying the process sequence only, as from this it would be inferred that wet galvanizing, which eliminates fluxing and drying, is more economic than dry galvanizing. However, in wet galvanizing only half the pot surface is usually available for dipping which means a double-sized pot for a half-sized output. The choice of method must be considered in close relationship to the facilities for dipping, the shape of the article and the size of the existing pot.

A very rough breakdown of costs in general galvanizing allows about one third for direct materials (including energy) one third for wages and one third for overheads. Developments in materials handling can improve the use of materials, but not on a large scale, but real improvements in materials handling may save half the wages, or alternatively, double the output for the same wages, thereby cutting overheads by half.

In general galvanizing efficient materials handling will benefit everyone concerned, and an approach to better materials handling can be made by simple methods and with common sense. Dependent on the size of the works, the improvements can be achieved either with the actual staff or with more or less assistance from independent work study engineers. When a galvanizer really wants to improve the efficiency of his materials handling (which means the overall efficiency in his works) he must refuse to be diverted from his purpose by the stock excuses so frequently produced.

The paper concludes with the description of a novel suggestion for a circular layout of a galvanizing installation.

Materials Handling in Galvanizing

F. M. CARLSON

[(American Tinning and Galvanizing Co.)]

THE saying " that in any industry making is 90 per cent handling " is closer to the truth for hot dip galvanizing than for almost any other industry, and it is only by taking full advantage of modern handling techniques that the galvanizer will be able to stay in business under the highly competitive conditions which prevail today.

Great advances have been made in recent years in the design and construction of plant and in knowledge of the technical aspects of the galvanizing process, and it is in the field of the movement of material to, through and from the galvanizing shop that large economies are still possible and in which common sense and ingenuity can still pay handsome dividends. In this respect there is no finality and handling techniques should be subject to continuous scrutiny to determine whether additional refinements are possible.

Although the specialized galvanizer has a considerable advantage so far as materials handling is concerned, the more difficult problems of the jobbing galvanizer can often yield to careful study. In view of the present labour position and rising costs salvation must lie in mechanization, and in some cases perhaps in complete automation.

The points made in the paper are demonstrated in terms of a number of actual examples from American practice.

Mr. F. C. Braby enlarges on the theme of materials handling.

DISCUSSION

MR. F. C. BRABY (Fredk. Braby and Co. Ltd.) said that it was not possible to work study every single item which was galvanized in a jobbing factory and as a result of visiting various plants in America and on the continent of Europe he was beginning to come to the conclusion that what was really needed in a jobbing factory was not so much a work study man but an engineer who would study the work so that he could consider the problems and suggest how best they could be met.

The layout was obviously the first and most important item, and that was absolutely paramount; but once the factory had been laid out the jobbing firm had coming into it every day all sorts of shapes of pieces. It might be possible to get some co-operation from the customer, who might be prepared to wait for some of his work a little longer, so that other work of the same kind could be put through at the same time ; but if one guaranteed a 24-hour service that could not be done, and it might mean that the baths would be standing idle for part of the time. It would also be necessary to store work.

The great problem in galvanizing was supervision, and the average supervisor probably had not the ability to do the kind of work which Mr. Braby had in mind, nor did he think that the average galvanizing firm had a man for it ; but any firm which did some fabrication work as well might find that it would pay to have a man to study this sole question of handling the material through the works in order to get it through in the best possible time.

WORKS VISITS

During the Conference delegates had the privilege of visiting a number of works of galvanizing interest in Belgium and the Netherlands. As part of this report on the Conference proceedings we include below brief descriptions of some of these works and galvanizing departments.

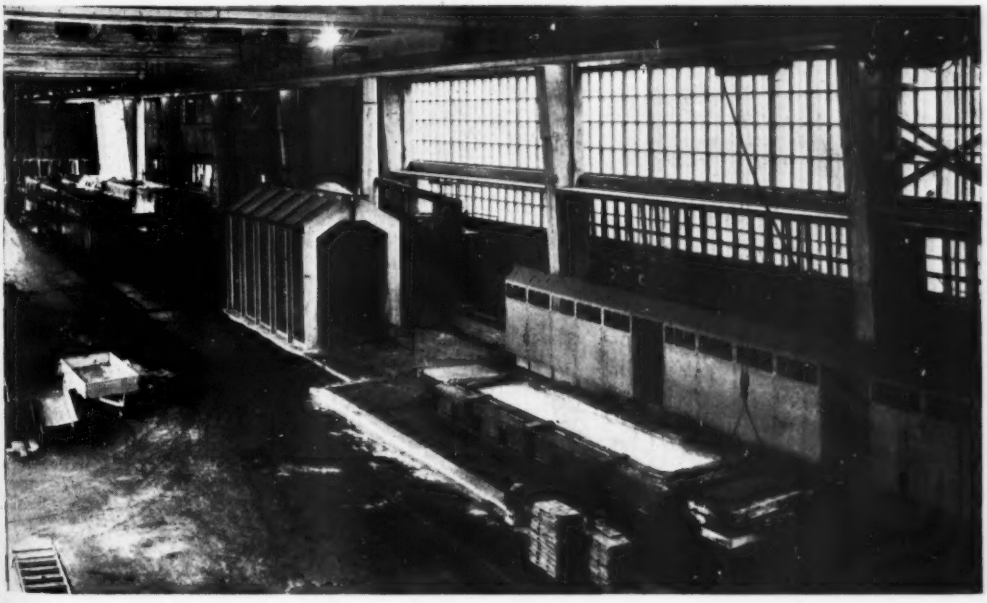
JOHAN VIS & CO. N.V.

IT was to meet the demand for engineering repair facilities created in Amsterdam by the evolution of the steamship that this company was founded as a small machine repair shop by Johan Vis nearly seventy-five years ago. Not long after its foundation, hot-dip galvanizing was introduced as a side line and developed to such an extent that in 1920 the engineering side of the business was disposed of and Mr. Vis specialized wholly in hot-dip galvanizing for the shipbuilding industry. Today the company is still solely engaged in jobbing galvanizing, not only for shipbuilding, but also for many other different industries throughout the country. In fact, to assist in broadening its field of activities and rendering it fully competitive, the company has developed special installations for galvanizing colliery equipment, steel windows, tubing and malleable iron fittings. Situated in the northern part of the town divided from the main town by the harbour, the works has excellent transport facilities, including a main road, a railway and a quay for ships up to 1,000 tons.

The main processing is all carried out in one concrete shop, 330 ft. long by 66 ft. wide and 40 ft. high. Besides this working area, there are a storage control room, a repair shop, welfare facilities and offices. Work for galvanizing is divided between two separate lines, one for small work to be hung on a conveyor or treated as centrifugal work, the other dealing with more bulky articles. All the installations on this latter line are standardized for work within the limits of 21 ft. long by 5 ft. wide and 7 ft. deep, to be handled in a single dip. This line, which operates mainly on the dry process, averages an output of 1½ tons per hour for general work and up to 6 tons per hour for specialized work. The small line mostly works the wet process giving an average output, dependent on the type of work, of from ½ to 1 ton per hour.

Handling facilities within the works comprise one mobile crane for unloading, five electric hoists on a monorail to serve the pickling tanks and another five for galvanizing, one electric jib crane for auxiliary work and another for loading galvanized work with a forklift truck for all other indoor transport. The total number of workpeople, including maintenance and transport, is 75. Heating for the galvanizing pot on the small line is by gas, and on the big line by oil, both with fully automatic control.

A general view of part of the main galvanizing shop of Johan Vis and Co. N.V.



N. V. PLAATWERKERIJ EN VERZINKERIJ v/h P. BAMMENS & ZN.

THE works of this company at Maarssen originated in a smithy which was founded at Geertruidenberg (North Brabant) in 1850 by Petrus Bammens. On his death the work of the smithy was continued by his two sons and a small factory extension was built in which were manufactured stovepipes and stoveplates, among other items. In 1875 the hot-dip galvanizing process was introduced to the works and from that time galvanized hollow-ware was included among its products. The works passed to other hands in 1917 on the death of the last of the Bammens, who left no successors.

In 1919 the factory was transferred to Maarssen and its steady growth dates from that time. The whole works area now involves some 21,000 sq. m. and provides employment for nearly 400 workpeople.

The choice of Maarssen in the centre of Holland on the main Amsterdam, Utrecht road as well as the Amsterdam-Rhine Canal, has made it possible to keep transport costs low, an important consideration, particularly in the case of general galvanizing.

Output from the sheet metal department includes a large range of galvanized hollow-ware, such as buckets, basins, washtubs, watering cans, etc. for both home and overseas markets, and a particularly famous line is the galvanized standard dustbin, used at present by over 80 per cent of the Dutch population and exported to several countries as well. Such other sheet metal products as manure tanks and pumps, pallets, gutters and gutter-pipes, are also produced by the company, whose interests are not confined to galvanized ware, being concerned in the manufacture of many articles of steel, stainless steel, and aluminium. The supply of steel ammunition boxes for the N.A.T.O. Army is one of the post-war activities of the company.

The galvanizing plant is the largest in Holland, comprising four galvanizing baths, two of which are 42 ft. long. This is used for general jobbing galvanizing as well as for processing articles manufactured in the works. The shop operates 24 hours a day on a three-shift system and some of the products passing through include heavy beams for the State Railways, high transmission towers, coolers, ventilation shafts and pipes for the shipbuilding industry, and structural steel members, in addition to a great variety of smaller articles. Where required facilities exist for chemical post treatment of galvanized surfaces. Other finishing processes operated by the company include electrodeposition, zinc spraying and sherardizing.

S. A. DES USINES A TUBES DE LA MEUSE

THIS company, which is the oldest one in Belgium making steel tubes, is also the only one in that country which produces the whole range of tubes, both welded and weldless. Its plant is divided between two principal factories, one comprising the head office at Flemalle-Haute, the other at Jemappes.

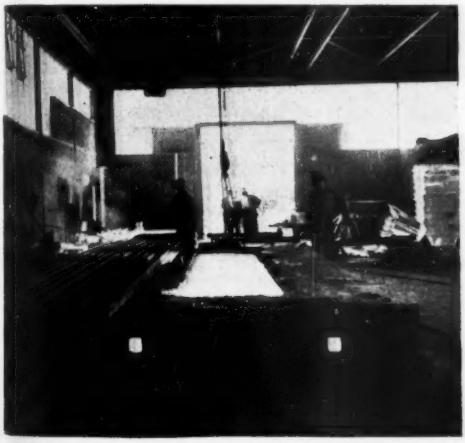
The Flemalle works comprises a rolling division for the fabrication of weldless tubing with a production capacity of 11,500 ton per month ; a cold drawing division which produces tubes of outside diameter varying between 6 and 150 mm. and wall thickness between 0.5 and 20 mm. at a monthly rate of 1,500 ton ; a large diameter welded tube division producing tubes from 250 to 1,250 mm. diameter at a rate of about 2,000 ton per month.

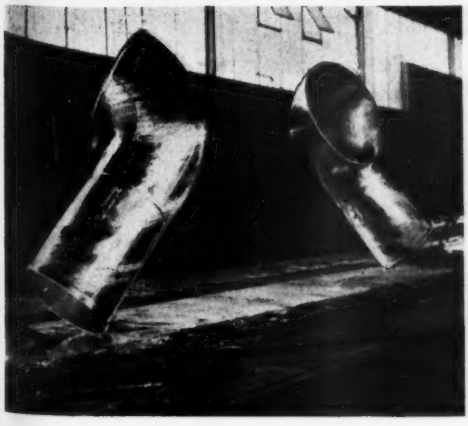
The Jemappes works fabricates gas tubing up to 4 in. dia., electrical tubes and thin tubes of small and medium diameter by resistance welding. The production programme of the thin wall tubing is particularly extensive by reason of the number of diameters and wall thicknesses which

An aerial view of the factory of N.V. Plaatwerkerij en Verzinkerij v/h P. Bammens & Zoon, at Maarsen

are in demand. In addition to some hundreds of circular section tubes there is also a range of other profiles such as square, rectangular, oval, hexagonal and other special shapes. This factory incorporates a tube galvanizing plant specially adapted to handling the company's products. Pickling of the tubes is carried out in sulphuric acid and all galvanizing is by the dry process. The most noteworthy feature of the plant is that the galvanizing bath is electrically heated. This is effected by surrounding the bath wall by a jacket of molten lead in which are immersed the electric heating elements. These develop a maximum power of 450 kWh. and are divided up into zones whose operation is controlled by thermocouples placed in the zinc bath and relaying through regulators. This method of heating has been found to be extremely flexible and easy to operate, requiring no supervision and avoiding all danger of local overheating or of outbreaks of fire. The galvanizing pot is 7.7 m. long, 0.8 m. wide and 1.2 m. deep.

Two views of the galvanizing shop of Verzinkerij G. Clements & Zoon showing the processing of long structural members (top) and of ventilator shafts (bottom)





The average consumption of electricity calculated over a year for all diameters of tubing and during working hours only is of the order of 115 kWh. per ton of tubes galvanized with an average hourly production of 3.1 ton. The thermal efficiency of the installation is excellent.

VERZINKERIJ G. CLEMENTS & ZN

THIS works, which is numbered among the principal Dutch galvanizers, extends over an area of 1½ acres on one of the main waterways from Rotterdam to the Rhine, and is well served with transport facilities, both by road and water.

In addition to the usual hydrochloric pickling tanks and drying ovens, the galvanizing plant comprises two pots, the larger of which is 21 ft. long x 3 ft. wide and 4 ft. deep. The dry process is used exclusively and the plant, which employs some 100 workpeople, is operated on a three-shift basis.

The company specializes in galvanizing a large variety of ships' parts, including pipes, tubes, railings, masts, boilers, fans, chains and air conditioning equipment. In addition a number of building accessories, including floor grates, balconies, windows and fences are galvanized and another speciality is hot-house constructions of all types, including gutters, wheelbarrows, wire buckets sieves and much other agriculture equipment. Facilities are also available for shot blasting and painting. The company has recently erected a new modern office building incorporating an attractive canteen for the office and shop workers.

TRAVAIL MÉCANIQUE DE LA TÔLE S.A.

THIS company has its principal works and offices at Forest-Bruxelles, in addition it operates works at Gand for the fabrication of light metal barrels, at Saint-Aubin-les-Elbeuf (France) for the fabrication of domestic galvanized ware, and at Istanbul for galvanizing sheets and manufacturing nails and shovels. The company also has important interests in the Belgian Congo in a factory manufacturing barrels and one turning out galvanized domestic ware and tin boxes.

The works at Forest cover a total area of 35,000 sq. m. Production from this works comprises fabrication of galvanized domestic ware, fabrication of beer barrels, fabrication of galvanized pipes and angles, mechanical galvanizing of sheets, and general sheet metal working and galvanizing. In

Part of the general galvanizing shop operated by Travail Mecanique de la Tole S.A.

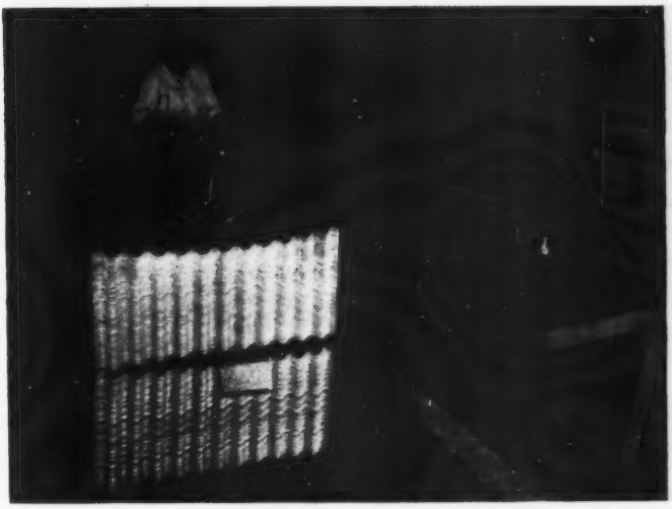
the near future a line for the production of gas and electric storage water heaters is to be started up.

Equipment in the galvanizing shop comprises 10 pickling tanks, 5 galvanizing pots for the treatment of domestic ware and fabricated articles and 1 line for mechanical galvanizing of sheets. The works is at the moment undergoing an important programme of modernisation, although this has been subject to certain unavoidable delays. One of the difficulties encountered has been that because of its particular situation the works has had to investigate the possibility of neutralizing the fumes exhausted from its pickling line. This has involved the experimental installation of a scrubbing tower fitted with a 50-h.p. exhaust fan in which the fumes exhausted from the pickle lines can be neutralized by a counter flow of alkali liquor. Up to the present time two of the pickle tanks have been connected to this tower and in view of the apparently satisfactory results the rest of the installation will be brought into the system.

At the same time one of the galvanizing baths has been experimentally equipped with a recirculatory heating system using gas oil. As this installation appears to be giving complete satisfaction all the galvanizing pots will shortly be similarly equipped. Handling in the processing lines is by roller conveyor.

The plant as at present set up processes 1,200 ton a month of pylons, structures, colliery tubs, tanks and various metal works, and it is anticipated that when the modernization programme is complete this capacity will increase to 2,000 ton per month.

A view of the line for the mechanized production of galvanized sheets at the works of Travail Mecanique de la Tole S.A.



Galvanized sheets leaving the corrugating rolls at the works of Societe Cockerill-Ougree at Seraing.

PHENIX WORKS S.A.

PHENIX Works, situated in the extreme south-west of the Liege industrial region, specializes in the production of light-gauge steel sheet, both plain and coated. The galvanizing facilities include a Sendzimir continuous line, a second of which is in process of installation, a manual sheet galvanizing plant, and a manual general galvanizing line. Output from these lines includes, in addition to sheet and strip, galvanized roofing accessories and house-hold articles.

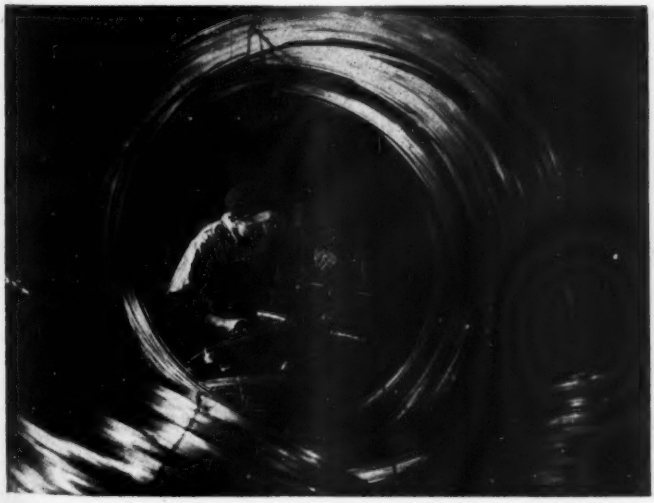
The company also produces hot-dipped tinplate and terneplate, and in the last three years has introduced to the European market " Skinplate "—a steel sheet coated with polyvinyl chloride.

COCKERILL-OUGREE (Seraing Division)

THE galvanizing department of the Societe Cockerill-Ougree at Val-St-Lambert (Seraing) is attached to the main steelworks of the Company and is wholly concerned with the conventional galvanizing of hot and cold rolled sheets by the wet process.

The department comprises four shops of 60 x 20 m. each devoted to a separate operation.

The pickle plant for hot rolled sheets is of Eatna standard design; the sheets are loaded into acid resisting bronze baskets immersed in sulphuric acid and agitated sufficiently to ensure that the



The manufacture of barbs for galvanized barbed wire in process at the works of Societe Cockerill-Ougree at Sambre-Escaut

sheets are separated from each other. The temperature of the pickling baths is maintained at 50-60°C. by steam injection and the average period of immersion for the load of sheets is half an hour. After pickling the load is given a cold rinse followed by neutralisation after which they are stored under water.

The pickle shop serves two identical galvanizing lines each of which comprises an initial dilute acid dip followed by a Thompson sheet galvanizing machine after which the sheets are allowed to cool in air on a chain conveyor. The sheets are then washed, flattened and sorted. The galvanizing baths which are 2.8 metres long, 2.135 metres wide and 1.5 metres deep, hold approximately 55 tons of zinc and are heated by coal fired burners.

A third shop contains the necessary equipment for corrugating and shearing the sheets after which they are passed to the last shop for packaging and dispatch.

An interesting feature of the plant is the reclamation system for sulphuric acid from the pickling plant. This is carried out in a Wiegand plant in which the waste liquor is heated to about 80°C. and brought up to strength by the addition of fresh acid. This solution is then concentrated by evaporation under vacuum produced by steam ejectors which can provide a vacuum of 740 mm. of mercury. The ferrous sulphate which crystallizes out is removed by centrifuging.

The monthly production from the plant is between 3/4,000 tons of sheets.

COCKERILL-OUGREE (Sambre-Escaut Division)

DURING the visit to the works of Cockerill-Ougree at Sambre-Escaut, delegates were able to see the production of wire in a wide range of qualities for many differing applications. Much of the wire produced in this works is subsequently galvanized for protection against corrosion and a considerable amount of development work has been carried out by the Company in improving the properties of the galvanized coating and in overcoming the possible adverse effects of the galvanizing process on the mechanical properties of the wire.

Normally galvanizing of wires of from .06-8 mm. is carried out on a continuous basis with a large number of wires being processed at the same time. The necessary heat treatment of the wire can also be incorporated as part of the galvanizing line. Some lines treat only mild steel wire while others process high tensile wires, while in some cases lines are adapted to dealing with both types of wire.

The No. 16 galvanizing line operated at Sambre-Escaut was installed in 1951 by the French company Collin. It comprises a galvanizing line for handling 40 wires at a time in any gauge between 5 and 22 mm. The successive operations are uncoiling, annealing in a lead bath, cooling, pickling in hydrochloric acid, rinsing, fluxing, drying, galvanizing and recoiling. The line is heated by gas and is designed for a production of 100 tons per day.

METAALBUIZENFABRIEK MIJ "EXCELSIOR"

A COMPLETELY new plant in Oosterhout for the manufacture of welded tubing of from ½ to 4 in. diam. was recently brought into production by Metaalbuizenfabriek Mij "Excelsior" which includes a pickling and galvanizing department with a capacity for processing 6 tons of tubing per hour.

The tubes enter the pickling shop singly and drop on to a tray from which they are picked up in bundles with chains and pickled in hot sulphuric acid. From the pickle they enter a cold rinse followed by a hot rinse and fluxing in zinc ammonium chloride. The tubes are then laid on a bridge from which they are mechanically picked up one by one and moved by roller conveyor to the galvanizing department where they are pushed on to a moving bridge for drying and pre-heating to about 120°C. The fluxed tubes are then carried on screw conveyors into the galvanizing bath.

After immersion in the galvanizing bath the tubes are moved by hand to a magnetic roll which draws them out of the bath and passes them through an air blast which removes excess zinc from the outside of the tube. Excess zinc from the interior of the tube is removed by a blast of super-heated steam after which the tubing is quenched and if necessary straightened.

The pickling tanks are made of concrete lined with acid resisting tiles and heating of pickling and fluxing liquors is by means of heat exchangers. Condensate from these exchangers is used for hot rinsing and all overflow from rinse tanks is continuously neutralised with lime in a special installation. After neutralisation the waste liquor enters a settling tank where the iron is removed and the clear liquor at a pH of about 8 flows off. Contamination of the fluxing liquor is kept at a minimum by continuous filtration.

Heating of the galvanizing bath is by gas with fully automatic control to maintain the temperature between 445 and 455°C.

FINISHING NEWS REVIEW

I.S.M.E. CONFERENCE TO HAVE SESSION ON FINISHING

Three Papers to be discussed at Annual Autumn Conference

One of the three sessions of the Annual Autumn Conference of the Institute of Sheet Metal Engineering to be held at the Charing Cross Hotel on November 5 and 6 this year will be devoted to some of the newest aspects of metal finishing. The availability of new materials and progress in mechanisation and automatic control will be taken into account.

During the second technical session of the Institute's meeting, three papers will be presented, each one dealing with a particular aspect of metal finishing. Titles and authors are :—

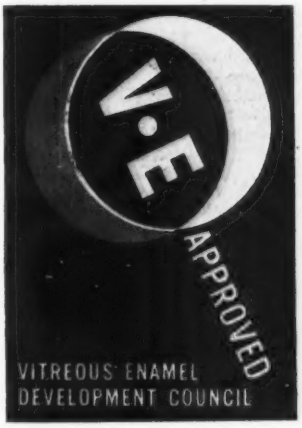
" Automatic polishing, with particular reference to the use of liquid polishing compounds ", by H. Silman and R. G. Hughes (Electro-Chemical Engineering Co., Ltd.); " Processing and painting of sheet metal components ", by W. Stein and E. Podmore (Joseph Lucas Ltd).; " Production of anodized finishes in automatic plants ", by A. W. Brace (Aluminium Laboratories Ltd.)

Non-members of the Institute desirous of attending the meeting are invited to communicate with the Hon. Secretary at John Adam House, 17 - 19, John Adam Street, W.C.2.

NEW V.E.D.C. WARRANT

AT right is the Vitreous Enamel Development Council Ltd.'s new warrant designed by Graham and Gillies Ltd. The warrant will be used in a national advertising campaign to be directed at the trade and the general public during September and October.

Objective of the campaign being launched by the Hollow-Ware Division of the council is to make the public aware of the advantages of vitreous enamelware as an attractive, hardwearing and hygienic finish for such things as kitchenware. Guarantee that goes with the warrant is one of fine finish and replacement of the article within 12 months should there be a manufacturing fault.



Contributing members of the Hollow-Ware Division of the V.E.D.C. are Edward Curran Engineering Co. Ltd., Jury Hollow-Ware Ltd., Ernest Stevens Ltd., and The Welsh Tinplate and Metal Stamping Co. Ltd.

MICROCHEMISTRY DELEGATES AT BIRMINGHAM WORKS

LAST month, 40 delegates from the Symposium of Microchemistry visited W. Canning and Co. Ltd. After a lunch at head office with the firm's chairman and directors, the delegates toured the works and laboratories. The symposium has attracted distinguished representatives of scientific interests from all over the world, and among the visitors to Cannings were representatives from Japan, Italy, Spain, Sweden and the U.S.A. In the picture below, the party is seen on arrival at the company's head office in Great Hampton Street.

Colour in Morris Plant

COLOUR experts and architects were called in to design the new £1m. plant at Morris Motors Ltd., Tractor and Transmissions Branch, Birmingham, now believed to house the largest collection of highly specialised gear-cutting and automatic transfer machinery in Europe.

A uniform colour scheme for the interior of the building and its 400 machines, some designed and built by the branch, was visualised when plans were laid down. On advice from a well-known paint manufacturer, a light green was used to harmonise with the modern lighting and to encourage operators in good "housekeeping".

Conveyor hooks carrying crown wheels and pinions through machining stages to the assembly lines are painted in three different colours, one for each series of vehicle from the Morris Minor 1000 and Austin A.35 to the Riley 2.6 and Austin A.105. The colours give employees a valuable visual aid.

VARNISH COATING LAMINATIONS

Controlled Temperature Process for Electrical Parts

ELECTRICAL power transformers for use with transmission of current at voltages up to 275 kV, are produced for both the home and export markets at the Walthamstow, London, factory of Fuller Electric Ltd.

The transformers consist of the usual two windings inductively coupled by a laminated iron core, but a comparatively recent development, cold-rolled grain-oriented silicon steel sheet 0.014 in. thick, is used in the construction of the core. The sheets are annealed at approximately 800°C., and then cut to size for laminating.

It is necessary to insulate each lamination with a suitable material—in this case a patented varnish. The varnish consists essentially of a sulphite cellulose which must be dried and cured after application to the laminations. The laminations can be coated on one or both sides, and to achieve a high space factor of active material in the iron core, the varnish film is only seven to ten microns in thickness.

The purpose of the insulating film is to restrict the circulation of eddy currents in the iron core to prevent overheating. The process is, therefore, subject to close quality control as regards thickness, evenness and insulation value.

The varnish is applied by passing the laminations between rubber covered rollers on to which the varnish is fed. The laminations are then fed on to a conveyor under a pre-heating hood before entering the stoving oven. The main conveyor oven is supplied by hot air from two direct gas-fired heaters supplying heat to the three heating zones. One heater supplies air to the final zone at a temperature of approximately 360°C., and the other heater the first and second zones at temperatures of 180°C. and 280°C. respectively, the heat for the first zone being bled from this heater.

Partial re-circulation takes place through a trunking system forming part of the construction of the oven.

Temperatures are controlled by indirect type thermostats, and recorded on a Negretti and Zambra 24-hour recorder to ensure accurate and economical operation. Electronic control equipment protects the plant against fan failure, flame failure, and faulty operation, and provides a simple and automatic means of starting. Design data of the unit is as follows :—

Controlled Heat and Air Ltd. combined varnishing machine, stoving oven and cooling section : temperatures adjustable up to 380°C.; Maximum gas rate 1200 cu. ft. of 500 B.Th.U. gas at 2½ in. w.g. pressure; heating cycle—1st Zone 10 ft. long, 180°C., 2nd Zone 10 ft. long 280°C., 3rd Zone 10 ft. long 350/365°C., cooling section 12 ft. Baking times : Adjustable between 0.5 and 1.5 min. Production, based on a 66 per cent space factor, is 1.0 tons per hr. at a speed of 30 ft. per min. Effective width of the unit is 3 ft. 6 in.

The plant is designed to handle cold rolled sheets and, therefore, rollers and other surfaces coming into contact with the sheets have been rubber covered to avoid introducing into the sheets internal strain that would impair the grain orientation. A take-off roller is incorporated at the unloading end of the unit to ensure that the sheets are delivered clear of the conveyor rods.

The maximum speed of the oven is 50 ft. per min. and the oven is ready for operation within 30 min. of lighting. The plant was chosen for its flexibility, since the core laminations vary over a wide range of sizes, according to the type and design of transformer.

FRITS RESEARCH CENTRE FOR O. HOMMEL

A NEW research centre being built for the O. Hommel Co., in Carnegie, Pennsylvania, is nearing completion. The new building containing many modern innovations will add over 20,000 sq. ft. of research facilities for ceramic research, and will have an extensive staff of trained and experienced personnel.

The new centre will have an air-conditioned, constant temperature instrument room. In addition to facilities for research on porcelain enamel and other ceramic materials, provision has been made for both static and dynamic testing of high temperature ceramic coatings.

The construction of the building uses ceramic products throughout. Architectural vitreous enamel and glass along with mosaic tiles augment the beauty of the exterior, while the interior design makes use of ceramic tile, brick, and vitreous enamel curtain walls.

Among the projects to be continued and undertaken in the new research centre are : the development of better vitreous enamel finishes for household appliances, improvement of high temperature ceramic for aircraft and missiles, and research work in area lighting in conjunction with major electrical companies.

The research centre will augment the company's "Oscar Hommel Memorial Fellowship", now in its 25th year at the Mellon Institute in Pittsburgh, for basic research in ceramic frits and chemicals.

NEW DIVISION FORMED

THE formation of a gas atomospheres division, was announced recently by The Incandescent Heat Co. Ltd., Smethwick, Birmingham. The division, headed by Mr. I. L. S. Golding, will co-ordinate the Incandescent Group's activities in this field, and will be responsible for design, development and sales of generators and gas dryers.

New Joining Process

BONDING NON-FERROUS METALS

A new process that can be used for bonding aluminium to aluminium, or to bond together other non-ferrous metals, has been developed recently, according to a report appearing in a recent edition of the "*Financial Times*".

The process is said by the scientists and engineers responsible for developing it to be especially suitable for use in mass production techniques, although it can be carried out equally well manually.

The operation of the process depends on the use of a reaction that produces what is virtually a solid solution of the two substances to be bonded together.

Three alternative compounds are available for use with the process.

The first of these is designed for use where exposed joints, such as butt joints, must be welded. A second has been developed for bonding broader surface areas, while the third compound is intended for use where low temperature joints must be made for large areas.

Since it is claimed that the process can be used to join dis-similar non-ferrous materials it is expected to have a wide range of applications in the engineering industry.

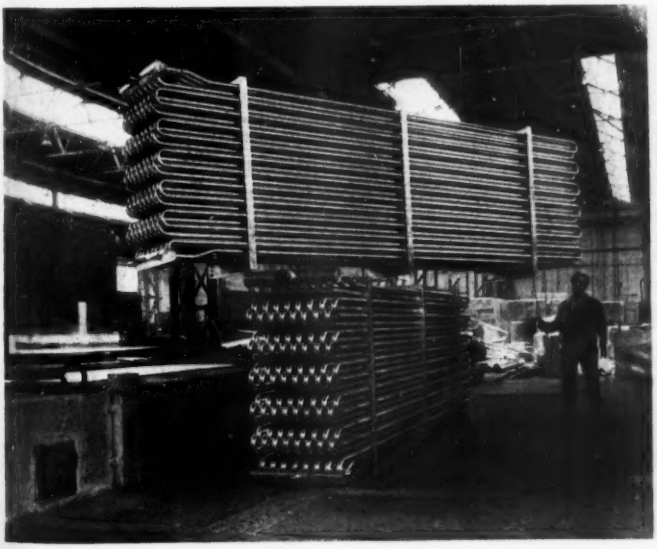
New Chief for S. African Co.

MR. William M. Frames, of Johannesburg, formerly chairman of Rand Mines Ltd., is the new chairman of The International Nickel Company S.A. (Pty) Ltd., South African subsidiary of The International Nickel Co., of Canada, Ltd.

Mr. Frames will be chief executive officer of a company engaged in mineral exploration and investment. The company is opening new offices in Palace Buildings, Pritchard Street, Johannesburg. Mr. Frames continues as a director of Rand Mines Ltd., with which he has been associated for 37 years, and as a director of other companies. He is a member of the Associated Scientific and Technical Society of South Africa and a Fellow of the Chartered Institute of Secretaries of London.

GALVANIZED COILS AT BLACKWALL WORKS

SEEN in the Blackwall, London, works of Richard Thomas and Baldwins Ltd. are two giant refrigerator coils, weighing 4¼ tons each. The coil had been galvanized for one of R.T.B.'s customers, G. Williams Engineering Co. Ltd., Willesden, London, who are to install the coils in an induced-draught ammonia refrigeration plant they have made for a West Country dairy manufacturer. The galvanizing job was one of the largest ever tackled at Blackwall.



V.E.D.C. DISPLAY AT OLYMPIA

MAKING the most of their campaign to promote the use of enamel hollow-ware in the kitchen, the Vitreous Enamel Development Council were exhibiting at the Domestic Equipment Trades Fair held at Olympia at the beginning of this month. Details of the campaign appear in page 365.

DETROIT M.F. CONFERENCE

TECHNICAL papers to be presented at the fifth international conference on electrodeposition and metal finishing so far total thirty-eight on a variety of subjects including new plating developments, corrosion and accelerated corrosion testing, physical properties of plated coatings, finishing processes for aluminum and the electropolishing of metals. Ten educational sessions are planned for the five-day conference to be held from June 14-19, next year, in Detroit, Michigan, U.S.A. by the American Electroplaters Society. Two of these will be devoted to organic finishing and the application of plastic coatings to electroplating equipment and fixtures.

Aluminium Cutback

A CURTAILMENT of about 10 per cent. in the rate of primary aluminium production at its Canadian smelters was announced recently by Aluminium Ltd. The company said that from last August its principal subsidiary, Aluminium Co. of Canada Ltd., had reduced its annual production rate from the previous 620,000 tons per year to a rate of about 560,000 tons per year, about 72 per cent. of installed smelter capacity.

Although sales in the second quarter this year increased 15 per cent. over the first quarter, production to date has been considerably above the level of sales. Approximately 400 smelter employees at Kitimat, Shawinigan and Isle Maligne will be affected.

EVAPORATORS FOR SALTS LIQUORS

FOR many years Associated Lead Manufacturers Ltd. have specialised in the manufacture of antimony and zircon compounds and, following on this, they have more recently developed the manufacture of lithium and its salts at Bootle, Liverpool. The production of these materials has reached the commercial stage, necessitating the installation of evaporators for handling the various liquors involved.

Two evaporators have already been working satisfactorily for two years, a third is in course of erection and a fourth is on order. All four are "Kestners" of various types, supplied by The Kestner Evaporator and Engineering Co. Ltd., of London.

The first is working on lithium sulphate and is a single-effect double-circulating climbing-film evaporator under vacuum. It has stainless steel contact throughout.

The second is a double-effect climbing- and falling-film non-vacuum evaporator with mild steel contact working on lithium hydroxide.

The third Kestner evaporator, now being erected, is a forced circulation salting type working non-vacuum with twin calandrias so connected that either may be isolated and cleaned whilst the plant is running.

The fourth now on order, another double-effect, will be a duplicate of the second, and will be used for concentrating lithium sulphate.

FINISHING COURSE

TWO evening and one day-time special course have been arranged by the metallurgy section of the Kingston Technical College, Surrey, Of the evening lectures, one starts on November 11 and deals with the technology of light alloys ; subject of the other, starting February 10, is the protection of metals against corrosion. The day course (1 day a week) is on corrosion and metal surface treatment. Organising lecturer is Mr. G. Isserlis from whom further details can be obtained.

PRESSED STEEL FOR SWANSEA

Refrigerator Divn. Will Move to S. Wales

BY arrangement with the government a large factory will be built for Pressed Steel Co. Ltd. in Swansea. It will be one of the most modern of its kind in the world and the plant will have a high degree of automation. This project repeats the precedent established by the company in 1947 when they helped to relieve unemployment by occupying a government sponsored factory in the development area of Linwood, near Glasgow, which is now employing over 2,000.

It is expected that 2,000 will be employed at Swansea within 18 months of occupation and that the labour force will increase to about 4,000 over the following four to five years.

It is estimated that the factory will be completed during the spring of 1960. The company will then transfer by stages the whole of its " Prestcold" refrigeration division, at present divided between the Cowley and Theale factories.

It is intended that all employees at the two factories now engaged on refrigeration will be employed in the company's expanding motor car body division, except for the key personnel required in Swansea who will be transferred on a voluntary basis.

Import Licence For Soviet Tin

AS from the end of last month, the Board of Trade say that imports into the U.K. of unwrought tin and tin alloys, originating in or consigned from the Sino/Soviet bloc, will be subject to individual licencing. The open general licence has been amended accordingly. The three-monthly quota from the U.S.S.R. will be 750 tons.

Mexican Mission

A MEXICAN trade mission arrived in London last week for a stay of seven days. The party is visiting this country in response to an invitation extended by the President of the Board of Trade during his visit to Mexico in January.

Senor Loyo, leader of the mission and Minister of Economy, visited Calder Hall and a steelworks. A number of meetings with industrialists and others concerned with trade with Mexico was arranged for the party who visited a number of factories in the U.K.

Z.D.A.'s Film Features Rust Prevention

FOR several years the Zinc Development Association and its affiliated associations have maintained a film library for the use of members and interested educational and professional bodies. The Z.D.A. has for some years been planning a series of films on the main applications of zinc, and the first film in the series, ' Work Study, Its Application to Team Work ', made in 1957, is devoted to general galvanizing practice. The second in the series ' No Rust Here ', was presented in this country for the first time recently. It shows how hot dip galvanizing gives reliable and lasting protection to iron and steel against corrosion under varied conditions, and examples of this have been chosen from both long-established and modern industries.

The film will shortly be shown in the Midlands and the North, with panels of galvanizing experts present to answer questions.

HUMPTY IN SAFETY WEEK

OFFICIAL figures show that in 1956, 22,548 persons were absent from work as a result of injuries following falls, equal to 14.1 per cent. of all reported accidents. The Royal Society for the Prevention of Accidents feels that everyone employed in industry should be reminded that " Extra Care Stops Falls," and has, therefore, adopted the slogan for this year's National Industrial Safety Week, to be held from September 29 to October 4.

The theme forms the basis of a nation-wide campaign directed to both managements and workers with the object of reducing the toll of industrial accidents, and particularly those associated with falls of persons.

To assist managements in organizing their own campaigns during Safety Week, the Society has prepared an attractive range of publicity material built round a little figure called " Humpty Dumpty." He sits on a wall, but unlike the ill-fated Dumpty, who had the fall to end all falls, he sits tight.

As a further encouragement to workers to interest themselves in the campaign, the Society has prepared a special poster slogan competition with £100 offered in prizes.

Stainless Steel Price Down

First Reduction Since War For Ferritic Strip

PRICE reductions for a certain type of stainless steel used mainly in the motor car industry were announced recently.

FI.17 ferritic stainless steel strip in sizes up to but not including 15-in. wide, will carry reductions in price according to thickness and width from £15 to £35 per ton.

This is the first reduction in the price of stainless steel since the war and a spokesman of Firth-Vickers Stainless Steels Ltd., one of Europe's biggest producers, said that the cheaper prices are expected to stimulate use in the motor industry.

FRICTIONLESS FINISHERS SHARE PROCESS

OWNERS of the McGregor system of frictionless finishing announced last year, Progrega Ltd. of Dundee, are to discuss the development of the process in Australia. Parts treated in Dundee have been tested extensively in Australia and a group of industrialists has now asked for sole rights in that territory.

Progrega Ltd. who have recently completed an arrangement with German interests for the exploitation of the process, have now arranged for the process to be used in Italy. A group of Italian metal-working firms have taken up the process and will develop it extensively in Italian engineering production. The German agreement, concluded at Frankfurt, will result in three companies being formed, two in Germany, with headquarters in Frankfurt and one in Zurich, Switzerland. One of the German companies will use the process in Western Germany ; the other will develop it throughout the rest of Europe except in Italy. Both these German companies will have the same directorates. The British company will retain a royalty interest in the use of the process. An approach has also been made by an American company for exclusive American rights.

DUTCH PNEUMATIC TOOLS FOR U.K.

AIR tools for metal treatment and finishing are assuming increasing importance in the engineering industry, particularly in shipbuilding and ship repairs and maintenance.

B. O. Morris, Ltd., Coventry, already well-known as makers of " Morrisflex " polishing shop equipment and flexible shaft machines, and for their own air tools, have extended this range by becoming sole agents in the U.K. and the sterling area for the " Grasso " pneumatic tools manufactured by the internationally famous Dutch company.

The range made available by the agreement is described in a catalogue issued recently by Morris, and comprises pneumatic drills, grinders, hammers and other accessories and tools.

CORROSION MEETING IN SOUTH WALES

THE South Wales section of the Society of Chemical Industry and the Cardiff section of the Royal Institute of Chemistry are holding a joint meeting at the King's Head Hotel, Newport, Mon., on Tuesday, September 16, 1958, at 7 p.m. for presentation of a paper " Some factors affecting the performance of condenser and heat exchanger tubes" by P. T. Gilbert, Ph.D., F.R.I.C., F.I.M. (Yorkshire Imperial Metals Ltd.).

The performance of condenser and heat exchanger tubes will be reviewed from two points of view : resistance to corrosion during service ; and the maintenance during service of proper rates of heat transfer to ensure the optimum functioning of the equipment.

Under the first heading, consideration will be given to the effects of polluted cooling waters, erosion by abrasive particles suspended in the cooling water, etc. The best alloy for use in various circumstances and the other steps that can be taken to ensure the longest tube life will be reviewed.

Under the second heading the effects of films, scales and corrosion products of heat transfer rates will be referred to and various methods of tube cleaning will be discussed.

Chairman of the meeting will be Dr. S. G. Clarke, D.Sc., A.R.I.C., F.I.M.

CHROME-DIFFUSED M.S. IN ANTARCTIC

ON the Smiths 50 A.S.M. combustion heater many of the working parts are fabricated from chrome-alloyed mild steel. These heating units were used very successfully to provide heated air for engines, living space, vehicles, etc., on the recent transantarctic expedition led by Dr. Fuchs. The Chrome-Alloying Co.'s chromium diffusion process enables mild steel parts to fulfil many of the purposes for which normally costly alloy steels are specified.

TECHNICAL *and* INDUSTRIAL APPOINTMENTS

The resignation of Mr. Charles C. Cooper from the board of directors of **Graham Firth Steel Products Ltd.**, due mainly to his other commitments, was announced recently.

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Mr. John Drabble has retired from the Editorship of the **Board of Trade Journal** and has been succeeded by Mr. James E. Holroyd, who has been the Board's chief press officer since 1944. Miss M. I. Lee has been appointed chief press officer.

The Board of Trade also announce that the Earl of Halsbury will retire from the position of managing director of the National Research Development Corporation on March 31, 1959, to take up another appointment.

Lord Halsbury was appointed temporary adviser to the Board of Trade in May, 1949, in anticipation of the establishment of the corporation and his appointment as its first managing director was made at the end of June, 1949. He was, therefore, responsible for the launching of the corporation and will, by next March, have directed its activities for nearly ten years.

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At the annual general meeting of **The Institute of Physics,** Sir George Thomson (Master of Corpus Christi College, Cambridge) was elected president.

Dr. R. W. Sillars was elected a vice-president, Dr. J. Taylor, honorary treasurer, and Professor F. A. Vick, honorary secretary. The two new ordinary members of the board elected were Dr. A. C. Menzies and Dr. J. Topping.

Sir Lawrence Bragg (resident professor and director of the Davy Faraday Laboratory of The Royal Institution) was elected to honorary fellowship in recognition of his eminent work and valuable contributions to knowledge in the field of physics.

* * *

The appointment of Mr. Stanley Field as chairman of **Venesta Ltd.** was announced last month.

He succeeds Mr. Henry Rutherford, who relinquished the chairmanship on medical advice, and in recognition of fifty years distinguished service has been created the company's first honorary president.

From 1948 to 1953 Mr. Field was senior partner of W. N. Middleton and Co., at the same time acting as financial and general advisor to a number of industrial concerns. In 1953 he became managing director of The Prestige Group Ltd. and shortly afterwards a director of the parent company, Ekco Products of Chicago,

Mr S. Field

one of the world's largest manufacturers of houseware. Two years later Mr. Field became a director of Venesta and in February this year he relinquished his directorships of Prestige and Ekco Products to become deputy chairman of Venesta.

Venesta has been reorganised so that it is virtually a holding company with autonomous operational divisions each headed by an executive director.

The foil operations of Venesta and the Empire Aluminium Company were merged recently into the Venesta Foil Division, which produces 40 per cent. of all aluminium foil rolled in Britain and meets 45 per cent. of the company's exports. This division also makes collapsible tubes and rigid containers for the dental, pharmaceutical and allied trades.

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Makers of temperature control quipment, **West Instrument Ltd.,** have announced the appointment of Mr. W. Proudfoot as Manchester area representative.

Mr. Proudfoot has had experience, as a physicist, in both research and practical production problems. He was engaged on instrument development and plant investigation with the Distillers Co. Ltd., at the British Industrial Solvents Division and subsequently an assistant development manager with the Tootal Ltd. subsidiary of John Watton of Glossop Ltd. His address is the company's Manchester office, Provincial House, 1 Brazennose Street.

West Instrument Ltd. have also appointed two new overseas agents. These are : South Africa, Autronic (Pty) Ltd., P.O. Box 3041, Johannesburg. And in Hong Kong and the Portuguese colony of Macao, Lepack Co. (1955) Ltd., G.P.O. Box 114, Hong Kong.

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The British Motor Corporation has announced that Mr. G. W. Rose, O.B.E., T.D., A.M.I.Mech.E., has joined the board of Fisher and Ludlow Ltd., as deputy managing director.

Mr. Rose served his apprenticeship at Wolseley Motors Ltd. from 1934 to 1938 and, after war service in R.E.M.E., rejoined that company in 1946 as production controller. In 1951 he was seconded to the Ministry of Supply to assist in vehicle production for the defence programme. Three years later, after the Austin-Nuffield merger, he was transferred to the Austin Motor Co. Ltd. at Longbridge as works manager, cars division, and became general works manager in 1955.

Mr. J. R. Moore has also joined Fisher and Ludlow Ltd. as quality controller. Mr. Moore was previously chief inspector, bodies, at the Austin Motor Co. with whom he has served in various capacities for 26 years.

Consequent upon these appointments, Mr. W. H. Davis, A.M.I. Mech.E., A.C.T. (Birm.), A.M.I. Plant E., formerly production manager, becomes general works manager at Longbridge ; Mr. R. D. Niven has been promoted to production manager, cars division, having been formerly works manager of the commercial vehicle division ; Mr. C. A. J. Munday has been appointed chief inspector, bodies, at Longbridge.

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The appointment of Mr. J. H. Clatty to the position of general foreman in charge of Frit and warehouse operations for the **O. Hommel Co.,** Pittsburgh, Pennsylvania, was announced recently.

Starting with the company in 1934, Mr. Clatty became supervisor in 1941, and foreman in 1943.

(*Continued in page* 371)

GOLDEN JUBILEE AS CHAIRMAN

Founder of Kestner's Celebrates Half Century

THIS year, Mr. J. Arthur Reavell, M.I.Mech.E., M.I. Chem.E., F.Inst.F., F.I.M., celebrates his fiftieth year as chairman of the Kestner Evaporator and Engineering Co. Ltd., a company he founded with a secretary and one engineer back in 1908.

To-day, the company has branches in South Africa and Australia, and has agents all over the world. Mr. Reavell can be found in his office or works most days of the week, and annually visits his overseas branches.

His early ambition was to be a chemist, but his parents thought he would do better as a student apprentice with a firm of electrical engineers. So he became an apprentice, and when he had completed his training he worked for a time with engineering firms in this country, and then went abroad to the U.S.A. and Canada.

From there, he went to the Continent where he met Paul Kestner. The two became friends, and in 1908 Mr. Reavell agreed to take over the British Empire rights in Kestner's climbing-film evaporator and other plant patents. To these he has since added a long string of his own, some concerning evaporators, others chemical plant and materials such as silicon iron, "Keebush" and "Keeglass."

His interests have always been in the application of chemical engineering principles and in new materials of construction. To-day, the industries where Kestner plant can be found range from steel and explosives to pharmaceuticals and fruit juice.

He says he has lived a full life, and intends to go on doing so.

Appointments

(Continued from previous page)

Mr. J. J. Boex, controller of associated interests of the **British Aluminium Co. Ltd.,** has been appointed a director of the company.

* * *

Mr. J. Allen, general manager of the Atlas Plating Co. for the past six years, has now been appointed general manager of **Mitro Anodising Ltd.,** Burlington House, Reynolds Road, London, W.4.

* * *

Mr. L. W. Smith has been appointed sales supervisor for the south Midland region of theabrasives division of the **Minnestota Mining and Manufacturing Co., Ltd.**

Mr. Smith joined the company in 1954 after having served with leading machine tool manufacturers in this country. He succeeds Mr. Frank Mills, who has joined the 3M international division.

Sprayed Gaskets

ACCORDING to a recent issue of "Metco News" published by the Metallizing Engineering Co. Inc., of Westbury, N.Y., U.S.A. pressure vessel covers are now being equipped with gaskets of sprayed aluminium, applied by the standard wire-metallizing technique. A spray-gun traversing mechanism ensures a uniform thickness of each gasket, a key factor in the process.

The coverplates are used to seal large flanged openings in tanks and bulkheads where the use of an inserted gasket is difficult for one reason or another. The aluminium spraying technique produces an unspliced gasket having ductility at low-temperatures.

NICKEL ALLOYS EXHIBITIONS

A SERIES of four-day exhibitions on the practical uses of nickel and its alloys are to be held in Newcastle, Leeds and Belfast, during September and October, by Henry Wiggin and Co. Ltd. The programme : the Royal Station Hotel, Newcastle-upon-Tyne, September 23-26 ; the Metropole, Leeds, from October 14-17 ; and the Grand Central Hotel, Belfast, October 28-31.

Running concurrently with each exhibition will be a series of lectures and film shows demonstrating the practical uses and welding techniques of Wiggin alloys.

Tickets are available from the local area office of Henry Wiggin and Co. Ltd. or direct from the head office at Wiggin Street, Birmingham 16.

METAL FINISHERS' TECHNICAL SALES MEETING

AT a recent technical sales meeting of Silvercrown, Ltd., attended by the directors, salesmen, engineers and chemists of the company, details of new products and processes were given. These include the completely redesigned range of high performance plating barrels and filters, as well as centrifugal dryers and resistance boards.

The "Supersonic" range of fast and bright plating solutions for copper, nickel, zinc, cadmium and silver, was also discussed and a film was shown featuring some of the latest automatic and manual plating plants installed by the company in actual operation.

Share Capital Acquired

THE whole of the ordinary share capital of Air Control Installations Ltd., Ruislip, Middlesex, has been acquired by Beyer Peacock and Co., Ltd. of Gorton, Manchester.

Mr. F. D. Moul, B.Sc., A.C.G.I. A.M.I.Mech.E., will shortly be retiring from his position as chairman and managing director of A.C.I. Ltd., but will continue to be associated with the company in an advisory capacity as director and president. General policy will remain unchanged and the company will continue to manufacture a wide range of air treatment equipment.

NEW COMPANIES

"Ltd" is understood, also "Private Co."

Figures = Capital, Names = Directors, all unless otherwise indicated.

Geoffrey Butler, July 24. £10,000. To carry on bus. of distributors and manufacturers of and dealers in paints, varnishes, protective substances and coatings, etc. Geoffrey D. Butler and Mrs. Jean M. Butler.

Fisher Segal, 2, Palace Gardens, Enfield, Middx. July 29. £2,000. To carry on bus. of applying decorative and protective coatings by use of painting, induction, deposition, passivation or any like processes to all kinds of metal, alloys, wood, plastics, etc. Clive U. Fisher, Jack Segal, Wm. F. Denison.

Juggins and Co. (Metal Finishers), 52 Barton Street, Birmingham, 6. August 5. £6,000. To take over bus. of "Juggins & Co." carried on at Birmingham, and to carry on bus. of polishers, enamellets, sprayers, exhibitors, japanners, lacquerers, etc. Thomas J. Casey, Derek T. Casey, Mrs. Winifred D. Casey and Graham P. Casey.

Pepper and Hope, 5, Hockley Street, Birmingham. August 8. £5,000. To carry on bus. of manufacturers of and dealers in electro and chromium plated goods, etc. Dennis L. Hope and Mrs. Nancy M. Hope.

From the Register compiled by Jordan & Sons Ltd, 16, Chancery Lane, London, W.C.2.

TRADE and TECHNICAL PUBLICATIONS

Research Bibliography No. 65 — "Comparisons of plastics with steel" has been issued recently by the Science and Commerce Department of the Sheffield City Libraries. It contains 9 literature references, published since 1953, to discussions on plastics as competitors of steel. Copies are available free upon application to the City Librarian and Information Officer, Central Library, Surrey Street, Sheffield, 1.

* * *

Catalogue E. 213 describing the Schloemann - Ruthner drum - type picklers was issued recently by Schloemann of Dusseldorf, Germany.

The drum-type picklers have been developed for cold rolling mills with a restricted output or a greatly fluctuating production. In the Ruthner process taken up by Schloemanns, the coil is inserted in the pickling drum at the charging point and is then lowered into the pickling tank. The drum turns first in one direction until the outside diameter of the coil corresponds to the inside diameter of the pickling drum ; it then turns in the opposite direction until the coil is rewound to its original size.

During the operations, repeated several times, the pickling solution flows over the whole surface of the strip and acts on the scale film. On average, the pickling lasts from 15 to 20 mins. The drum with the pickled coil is then rotated in both directions in rinsing, neutralising, and oiling or drying tanks, similar to the operation in the pickling tank. The coil is then removed from the drum at the discharging point.

* * *

The British Central Electrical Co. Ltd. have available a limited number of cloth-bound 256-page electrical catalogues, thumb-indexed and divided into twelve sections for easy reference to : switchgear, cable, conduit and fittings, motors, starters and plant equipment, heating, lighting and ventilating equipment, instruments, electrical accessories, domestic appliances, portable tools, flameproof equipment, etc. Copies free on application to the company at 6-8 Rosebery Avenue, London, E.C.1.

* * *

Flow coating plant is featured in Brochure No. 70 issued by Stordy Engineering Ltd., Cumbria House, Goldthorn Hill, Wolverhampton, Staffs. The advantages of the flow coat system of painting are chiefly where articles of considerable size are to be treated on all surfaces which, with conventional dipping plant, would result in an uneconomical paint volume being required in the dip tank. The 5-page brochure is illustrated with examples of the system at work on several production lines, and includes a diagrammatic representation of layout for a refrigerator painting plant.

* * *

In a catalogue recently issued, Micro Methods Ltd., East Ardsley, Wakefield, Yorks, list the microfilm, microfiches and microcard material now available from them, including several on metal finishing and corrosion prevention.

* * *

"Bulletin S-200, Ultrasonic Cleaning," is the title of a new illustrated booklet based on 12 years of experience in the field, now available from Branson Ultrasonic Corpn., Stamford, Conn., U.S.A. In 24 pages, practical applications and basic principles of this modern cleaning method, as well as design of equipment, are described.

Design information occupies much of the booklet. Under general system considerations, batch immersion, conveyor and multi-stage systems are discussed, along with various transducer arrangements. Information on solutions and chemicals recommended for ultrasonic cleaning is also included.

A number of methods of evaluating performance are given. One involves the addition of a known quantity of radio-active soil to the part being cleaned, then measuring the amount remaining after a certain time. In a simple shop test, graphite from a soft pencil is applied to a frosted glass slide, the slide covered with another and immersed for half a minute in the ultrasonic cleaning tank. No trace of graphite should be left on either slide.

The bulletin is free on application to the company.

* * *

In a publication entitled "Electroflo Service" Electroflo Meters Co. Ltd. (member of Elliott-Automation Ltd.), Abbey Road, Park Royal, London N.W.10 outline the extent of their activities in the research, application engineering, installation-commissioning and maintenance fields for their complete range of instrumentation and automatic control equipment. Of particular importance is their fluid dynamics laboratory, used regularly by major plant manufacturers to investigate fluid flow problems and the design of ducting, flow piping layouts, valves, etc. The publication is free on application.

Latest Developments in PLANT, PROCESSES AND EQUIPMENT

Versatility of Non-Plastic Stopping

THE list of trades and industries served by the various products manufactured by Brummer Ltd., Oyster Lane, Byfleet, Surrey, includes the foundry and sheet metal trades, ship and boat building, etc.

Of especial interest to metal workers is Brummer stopping, since it adheres to iron and will not chip off once it has set. It can be used for castings, blow-holes, chips and roughcasts, and can also be very successfully adapted for filleting.

The stopping is made under various labels, *e.g.*, blue label, Brummer standard cellulose stopping, is particularly used by metal sprayers, and is popular for all metal finishes. Made in standard grey, this is a petroleum product, and is supplied in 8 oz., 2 lb. and 8 lb. size tins. Green label, Brummer waterproof stopping, sets firmly to iron, and can be cellulosed, polished, painted or varnished when dry. Like all the stoppings supplied by the firm, it is ready to use, sets rapidly, and does not sink. It is made in most colours and special shades.

Brummer stopping is also widely used for pewter modelling, and in making up brooches, where it eliminates the necessity for paste and adhesive.

Dust Collection Without Mechanical Movement

A MAJOR improvement in dust collection is the claim made for the new Mikro-Pulsaire collector, an American machine now being manufactured under licence in this country and marketed by Pulverizing Machinery Ltd., Fishponds, Bristol (*Fig.* 1)

Main advantage claimed for the collector is the complete absence of internal moving parts. It uses a method of continuous air filtering of powder and dusts, dispensing with the need for mechanical systems of filter cleaning.

The principle is conventional insofar as the dust-carrying air passes into cylindrical filter elements composed of woollen and synthetic felts, four ft. or six ft. long, leaving the dust to fall from their external surfaces for collection at the bottom of the pressure cabinet. A problem in this type of equipment has been to clear the thick layers of dust from the filter cloths covering the cylinders to enable the collector to work efficiently, since mechanical methods of cleaning the cloths caused considerable wear.

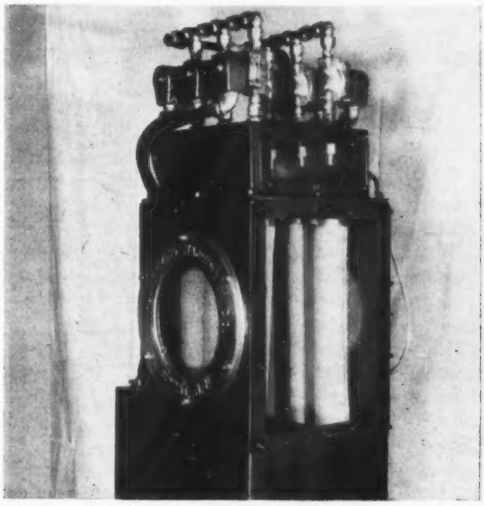


Fig. 1.—*This American designed dust collector uses reverse air blasts to clean the filter cloths*

The Pulsaire does this by periodical high pressure air currents in the reverse direction to the filter flow, that is, from inside the cylinders. Above the opening in the head of each cylinder is a nozzle connected to a compressed air supply of 60-lb. per sq. in. through a solenoid control valve. An electrical timer opens each valve in sequence for whatever period and frequency is desired.

The contoured design of the cylinder openings causes a venturi action and induces a secondary flow of sufficient volume and pressure to clear the filter cloths against the filter flow pressure. The dust adhering to the outside of the filters is blown away before it is thick enough to impede the rate of collection.

A great advantage of the system is that it needs practically no maintenance. The employment of compressed air instead of mechanically moving parts enables the unit to operate for long periods without attention.

The makers claim that in one field test, filtering copper powder, the Mikro-Pulsaire unit ran for nearly 3,000 hrs. without a single failure, and in over five months it has received no maintenance, although working 24 hours a day, 6 days-a-week.

The equipment is especially suitable for use with abrasive and toxic dusts since there are no moving parts to be damaged, and the cabinet seldom needs to be opened for inspection.

The manufacturers state that an extensive research and development programme is now under way. One of the problems they are tackling at present is to find a suitable filter medium to withstand temperatures up to and around 1.000° centigrade. There are also plans for the development of a purely pneumatic timing device to control the duration of the reverse air jet.

Hypalon

HYPALON is a synthetic rubber possessing physical properties that make it very useful to industry. Its resilience is good and its abrasion resistance and ageing properties are excellent.

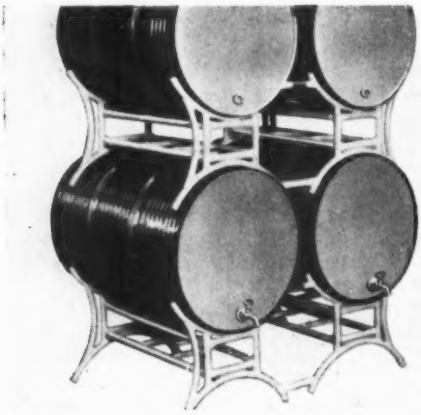
Outstanding results have been obtained when the material has been used as a hosepipe to convey concentrated sulphuric and chromic acids, hypochlorites and other strong oxidising agents.

H. C. Haselgrove and Sons Ltd., 19-21 Nelson Street, Birmingham 1, have had Hypalon spread on cloth so as to provide a double proofed material suitable for apron manufacture. Used for this purpose, Hypalon appears to lose none of its abrasion or acid resisting properties. Although the Hypalon aprons cost a little more than either conventional rubber or P.V.C. coated aprons, the makers claim that their working life is very much longer.

Drum Storage Unit

A UNIT of novel design, recently introduced by Powell and Co., Burry Port, Carms., S. Wales, allows steel drums to be stacked up to five tiers high, using a fork lift truck. (Fig. 2). Each drum is securely cradled and the forks are safely positioned under the load during stacking.

Fig. 2.—Tubular steel racks facilitate drum transport and storage



The units are of tubular steel and can be easily carried by one man. Each unit holds two drums and no permanent fixtures are required to enable drums to be stored neatly and safely, without danger from slipping as in pyramid stacking. The units can be used either inside or outdoors.

Two Plating Barrels

TWO plating barrels, one called the "Self-contained" and the other the "Mi-Nute," are being marketed by Sonic Engineering and Equipment Ltd., 120-130 Parchmore Road, Thornton Heath, Surrey.

The "Self-contained" plating barrel is a compact unit with its own rectifier. The barrel is made from polythene, and can be lifted out of a steel framework so that it can be replaced by a similar container for other plating processes. The anode and cathode fixture is fitted to one support rod that can be easily removed from its socket. Dimensions are 9½-in. deep x 7½-in. dia. with a minimum capacity of 3 pints of articles.

In addition, the unit can operate a small plating tank, and can also supply the current for operating the Hull Cell for testing various solutions.

The "Mi-Nute" plating barrel is a bench mounted unit that can be fitted with either of two sizes of barrels, one being 4-in. dia. at the top and 6-in. dia. at the base, and the other being identical to the barrel used with the "Self-contained" unit.

Both the "Self-contained" and "Mi-Nute" units can be used in conjunction with each other and are suitable for all processes including the plating of precious metals such as gold, silver, etc.

Self-Adhesive Labels

A SELF-ADHESIVE "Tickotab" name plate that can be supplied in any shape or size to suit specific requirements was introduced recently by John Gosheron and Co. Ltd., Albert Embankment, London, S.E.11. Supplied in a wide variety of base materials, such as P.V.C., ivorine, brass, alloy, aluminium, etc., and a wide variety of finishes, satinized, anodized, etched, engraved, etc., there are no restrictions as to style or colours.

The name plates will adhere to most metals, wood, glass, plastic, rubber, and many other difficult labelling surfaces.

The product obviates any of the drilling, pinning, and locating normally required for conventional plates, and no chemical treatment or activation of the adhesive is required before use. No action is necessary other than to remove the protective backing and press the plate into position.

(*Continued in page* 376)

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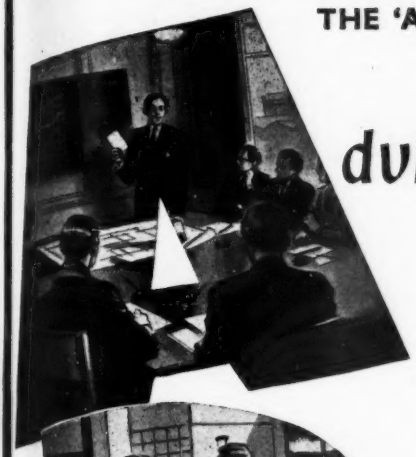

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Plant, Processes etc.

(*Continued from previous page*)

P.V.C. Fume Cupboard

TO meet the increasing demand for inexpensive, lightweight fume cupboards, Turner and Brown Ltd., Davenport Street, Bolton, Lancs., have produced the "Turbro" press-moulded fume cabinet, using the latest transparent wire reinforced rigid P.V.C. (Fig. 3).

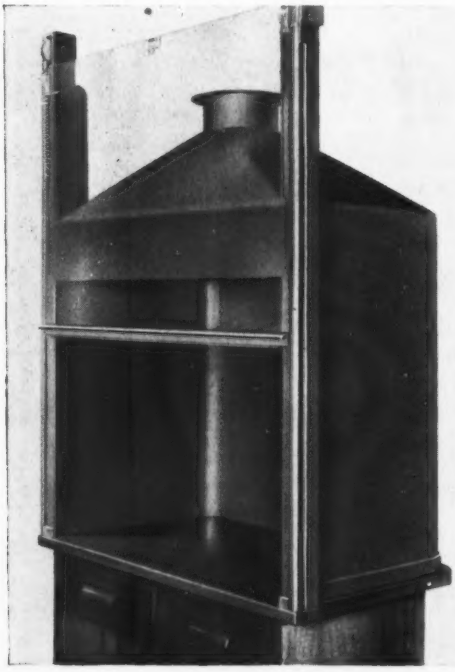
The cabinet can be supplied without base for fastening to existing bench tops by simply screwing down the P.V.C. flange around the base; alternatively, a P.V.C. working surface can be provided.

The cabinet is press moulded in 4 separate parts: top, back and sides, and two sash runners.

The sliding sash can be supplied in Georgian wired polished plate glass, wire-reinforced transparent P.V.C. (absolutely shatterproof), or "Perspex." The last-named is not recommended for strong acids and alkalis.

The lead counterbalance weights are totally enclosed in the press-moulded runners, but are easily accessible by removing two cover plates bolted to the top of the sash runners. Pulleys carrying "Terylene" sash cords are manufactured from P.V.C.

Fig. 3.—A press-moulded P.V.C. fume cupboard has a transparent sliding slash.



The transparent sheet eliminates the need for light fittings, or side windows, has immense strength and will not warp at comparatively high temperatures.

Large Polythene Containers

What is claimed to be an entirely new process for the production of polythene containers in sizes up to 50 gal. capacity has been introduced to Britain by Tool Treatments (Chemicals) Ltd., Colliery Road, Birmingham Road, West Bromwich, who are co-operating with a German firm. The containers are made in various sizes, in a one-piece moulding, and have lids designed for stacking. A 7-gal. size should be an ideal utensil for industrial chemical mixing processes. The containers are manufactured by the German "Engel" process, a system that makes short runs of products to customers own designs a practical proposition.

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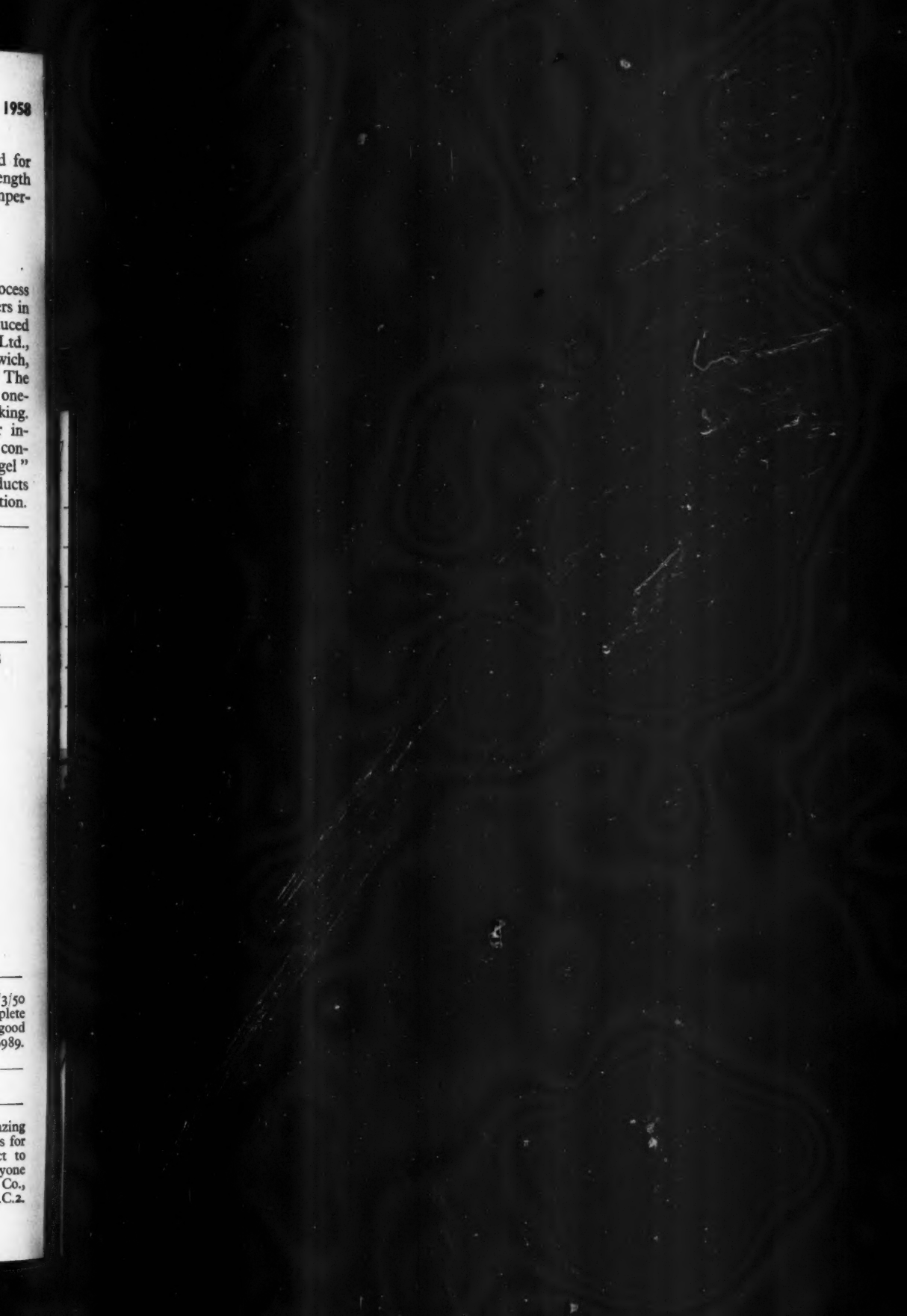
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